# Metal Treating

APRIL
MAY 1961

Vol. 12 #2



THE *ONLY* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

# Metal Treating

THE ONLY MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY



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### FEATURES



### DEPARTMENTS



• • •

*Indexed in Engineering Index*

APR.-MAY 1961 BPA VOL. XII No. 2

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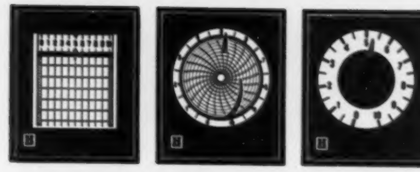
**About Our Cover**

After more than forty years in downtown New York, Fred Heinzelman and Sons, Inc., have moved to gleaming new facilities at Carlstadt, New Jersey. The new plant, designed to meet the accuracy and requirements of precision heat treating, typifies the progressive outlook of one of the industry's pioneers. Shown on the cover is a new atmosphere controlled double hearth automation shaker furnace which has been in use for several months at the new location.



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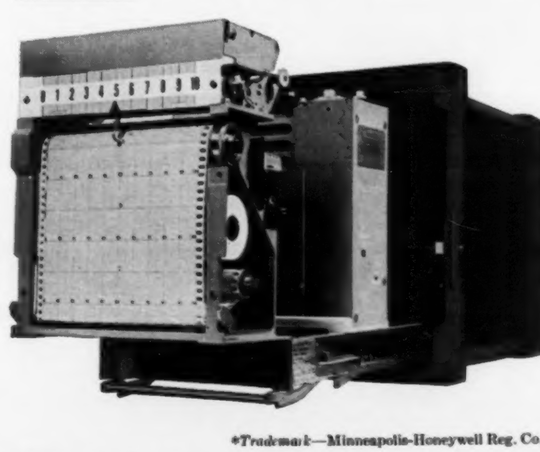

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From left to right: Dominic K. Monaco, Vice President, Eastern Heat Treating; Robert R. Shellman; Thomas J. Clark, Eastern Division Manager, Park Chemical Company.

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*For further information circle No. 40*

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**Read how Shell Voluta 921 can help eliminate staining problems in your heat treating operation—reduce rejects—and give you better brightness outside, better hardness inside.**

As metals are being used to pierce the earth's crust, explore the far reaches of the universe and carry man faster than the earth's rotation—heat treating is becoming one of our most exacting sciences.

*Shell's new quenching oil, Voluta 921, was created to give that science even greater precision and uniformity of result. Recommended for metal that has been treated in atmospheric furnaces, it is the first premium quench oil to help assure high surface brightness and fast cooling without warpage, cracking or distortion.*

"Good looks" and toughness don't combine easily in the same piece of metal.

### Brightness or hardness?

In the past, quench oils have been able to provide one or the other. A well-hardened piece, or a bright, stain-free piece with good visual quality.

*New Voluta 921 quenching oil gives both—and with remarkable speed.*

How does Shell's Voluta 921 deliver these *two* benefits while other quench oils can supply only one?

### New formula does it

The extra measure of brightness comes from a special formula developed by

## BULLETIN, CONT'D.

Shell Research. This formula has been exhaustively tested and proved at Shell's Wood River, Ill., Laboratory.

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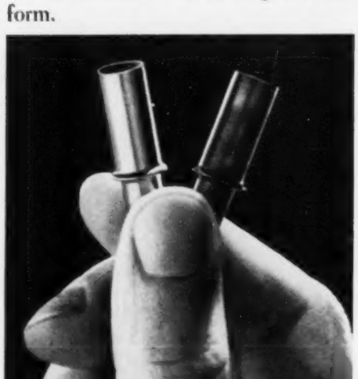

**Stain-free part** on left was quenched in Voluta 921.

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### A user reports

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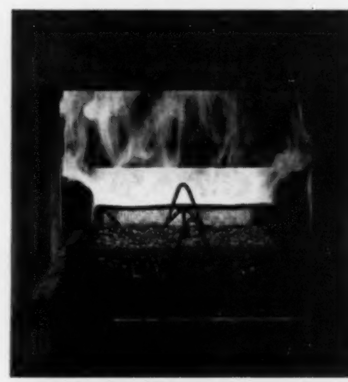
**1.** It has helped Kober's staff eliminate rejects due to spotting and staining.

**2.** Voluta 921 has produced uniformly excellent results throughout the shop. And, at Commercial Metal Treating, that's saying quite a lot. They have 14 furnaces which require quench tanks. This includes *six* different types of furnaces—from an atmosphere-controlled shaker to a string of salt bath and induction units. *"Mike" Kober has now standardized on Voluta 921—uses nothing else.*

**3.** Voluta 921 has unusually high resistance to oxidation and sludging—thus, prolongs the usable life of the oil.

**4.** The outstanding bright-quench quality of Voluta 921 has given Commercial Metal Treating a stronger hold on regular business—has also made possible a "showable" sales point for attracting new business.

These benefits of Shell's Voluta 921 can improve metal hardness and heat treating efficiency in your plant, too.



**Basket of parts** entering atmosphere furnace. Furnace has integral quench tank—filled with Voluta 921.

### Call your Shell Representative

Ask your Shell Industrial Products Representative for all the facts on new Voluta Oil 921. Or write: Shell Oil Company, 50 West 50th Street, New York 20, N.Y.

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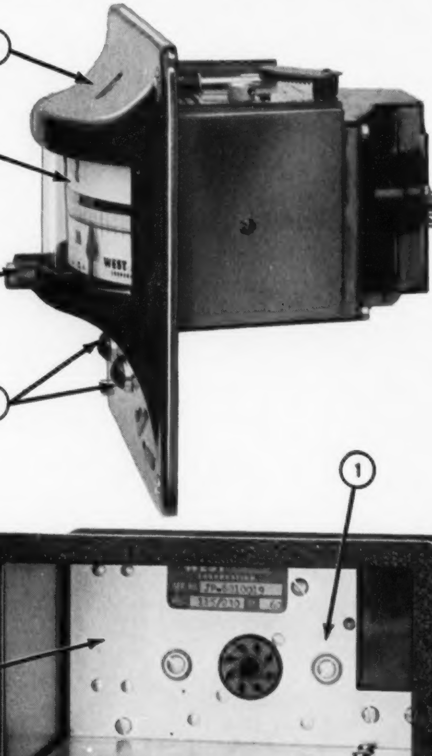

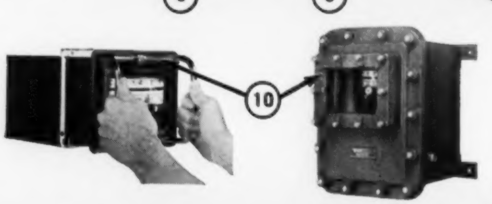

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*For further information circle No. 35*

## CARBON CONTROL DURING

# High Temperatur

WHEN HIGH TEMPERATURE CARBURIZING applications and specifications require extra care and control, regulation of dewpoints and atmospheres becomes a critical factor. In our plant the majority of furnaces are batch type controlled atmosphere units with several furnaces supplied from a single generator. This requires operation of the generator at a nominal dewpoint, adjustment being made at the various furnaces with natural gas or air additions to obtain the required potentials. All of the furnaces are equipped for monitoring and recording of atmosphere dewpoints, with automatic control for selected units. Likewise, the endothermic generators are provided with automatic dewpoint equipment for maintaining preset control. Occasional Alnor and dew cup measurements are made for comparative checkout of this equipment.

Automatic control of furnace dewpoint is used for applications falling in four categories, all involving restrictive carbon ranges:

1. Restoration of decarburized surface of precision castings (0.18-0.23% carbon range).
2. Homogeneous carburizing or carbon restoration (0.40-0.50% and 0.060 in. to 0.070 in. carbon range).
3. All carburizing cycles.
4. Selected carbonitriding cycles.

The specification covering precision castings is very critical due to their highly stressed application and restrictive carbon limits that undergo subsequent welding operations. A control dewpoint of +65 F. is used. Actual control is accomplished by introducing air directly into the work chamber in excess of the required amount, and natural gas additives are introduced through a solenoid operated by-pass system, to bring the dewpoint down to the +65 F. setting. This method is easier to control than direct modulation of the air additive.

At these low carbon and medium carbon ranges there is very little problem maintaining reproducible results. Available charts on carbon-dewpoint-temperature relationship are reasonably accurate and can easily be adapted to the specific process. However, it is necessary to keep in mind the fact that compensation may be required for natural gas and ammonia additions, surface area of the work, tightness of equipment, and other factors affecting atmosphere equilibrium reactions.

A basic relationship to generator-furnace dewpoints may be of some aid as a preliminary checkout of equipment (Figure 1).

The dewpoint of the generator and the furnace should be identical at a furnace operating temperature equal to that of the generator. A generator operating at 1850 F. producing a +30 F. dewpoint atmosphere, and a furnace operating at 1850 F. with this same atmosphere should also register a + 30 F. dewpoint. There must be equilibrium conditions in the furnace to maintain this relationship, and, in practice, it may require a considerable period to reach this condition. A deviation could indicate a furnace or generator problem, possibly incorrect temperature control of furnace or generator, or excessive leakage at the furnace. This relationship may not hold true for all makes of equipment, as the critical factor remains the reaction temperature of the generator. Relationship of retort temperature to control thermocouple must be determined before any compensation can be applied.

The relationship of dewpoint as inversely proportional to carbon potential, with the potential being inversely proportional to temperature, involves a consideration of the relationship between temperature and dewpoint variables. The important factor sometimes not considered is that as the temperature increases, measured dewpoint changes.

A typical charted sequence for various furnace temperatures, while maintaining a constant atmosphere flow, might read as follows:

FURNACE TEMPERATURE EFFECTS ON DEWPOINT

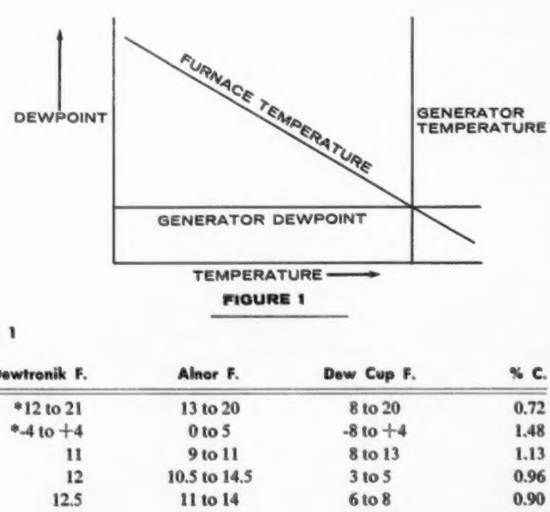


FIGURE 1

TABLE 1

| Heat | Generator Dewpoint F. | Nat. Gas Additive | Dewtronik F. | Alnor F. | Dew Cup F. | % C. |
|---|---|---|---|---|---|---|
| 1 | *20 to 22 | 3 CFH (constant) | *12 to 21 | 13 to 20 | 8 to 20 | 0.72 |
| 2 | *16 to 20 | 7 CFH (constant) | *-4 to +4 | 0 to 5 | -8 to +4 | 1.48 |
| 3 | *24 to 27 | 1 to 4; 1 to 5 CFH (adjust) | 11 | 9 to 11 | 8 to 13 | 1.13 |
| 4 | 20 | 2 to 5 CFH | 12 | 10.5 to 14.5 | 3 to 5 | 0.96 |
| 5 | 18 to 20 | 2 to 5 CFH | 12.5 | 11 to 14 | 6 to 8 | 0.90 |
| 6 | 20 | 2 to 5 CFH | 13 | 11.5 to 13.5 | 8 to 16 | 0.87 |
| 7 | 20 | 2 to 5 CFH | 11.5 | 9 to 14 | 10 to 13 | 1.00 |

*Not on control.

# Carburizing

ROBERT W. KROGH, Manager
Ipsenlab of Rockford

| Temperature | Dewpoint |
|---|---|
| 1500 F. | +57 F. |
| 1600 F. | +48 F. |
| 1700 F. | +39 F. |
| 1800 F. | +31 F. |

(Generator operating at 1800 F. with +32 F. Dewpoint).

Figure 2 shows the carbon potential-dewpoint data that applies to the temperature ranges that are considered practical for carburizing. These curves are plotted from recent test data selected from sample processing and production runs. Previously reported information has indicated a temperature of 1900 F. may be practical for many applications, and several sample runs have been made at this temperature. A normal 0.85-1.00% C specification would require dewpoint control within an estimated 2 F. range at this temperature. A comparative 4 F. deviation would be allowable at 1700 F. This indicates the critical need for automatic control.

One such test series was run to evaluate the possibilities of elevated temperatures for carburizing bearing retainers. Although this application would not be considered ideal because of dimensional tolerances, a review of the results may be enlightening. These parts were carburized in an Ipsen TC-150 furnace at 1900 F. for three hours to produce a 0.040 in. to 0.050 in. effective case. Carbon step down bars and shim stock specimens were run with each load. The furnace was conditioned to the selected dewpoint before loading. Alnor and dew cup readings were made at frequent intervals in addition to recording and control with an Ipsen Dewtronik dewpoint controller. The first three runs were preliminary attempts to check out previous cycles and establish general natural gas additive ranges. Generator atmosphere was supplied from a unit on manual control. Results indicate the value of positive dewpoint monitoring directly at this source. In heats number 1 and number 2, constant natural gas additions were used, with no attempt to automatically control dewpoints at the furnace.

Prior tests had indicated approximately five to 10 CFH natural gas would be required for proper control with a +30 F. dewpoint generator atmosphere.

In Table 1, results of carbon determinations are all from step down bar analysis and indicate a natural sequence with respect to dewpoint control settings. These runs, although in progression, covered a period of two weeks, and were scheduled between production loads. The furnace was conditioned prior to each load.

Figure 3 shows there is a tendency to vary form control near the end of the cycle. The maximum 4

*Continued on page 23*

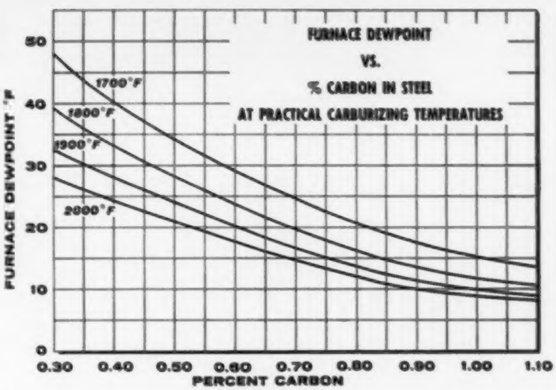


FIGURE 2

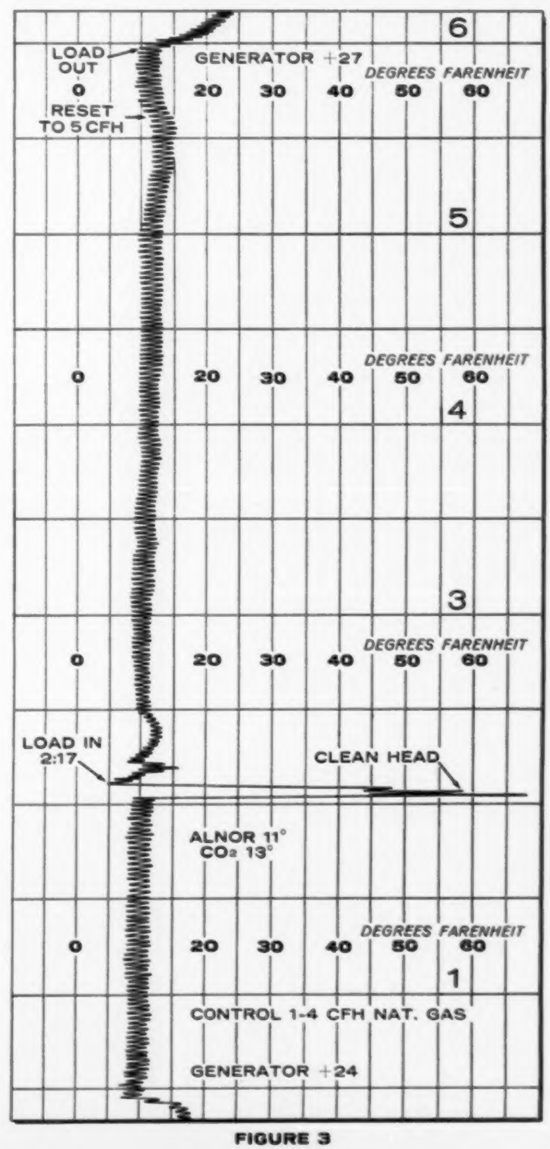


FIGURE 3

# EFFECT OF HARDENABILIT

By

E. I. MALINKINA

Translated from *STANKI I INSTRUMENT* [Russian Journal*]

SYNOPSIS

*Study of formation of cracks in shank tools of 1.0 and 1.2% C steels as affected by cross sectional area and, hence, hardenability of tools. Preparation of specimens; dimensions: 5 - 35 mm. (0.2 - 1.4 in.) square. Experimental procedure. Effect of quenching temperature on number and shape of cracks. Explanation and shape of cracks. Explanation of the three different types of curves obtained that express this relationship. Conditions favoring bow-shaped cracks; formation of longitudinal cracks: factors governing it. Core hardness as function of quenching temperature and cross sectional area of tools. Susceptibility of fully and incompletely hardened tools to cracking.*

MANY TYPES OF TOOLS are made of low hardenability steels. The hardenability of a tool varies with its cross section. And while tools with small cross-sectional areas harden throughout, only a surface zone can be hardened to high hardness in tools having a large cross-sectional area.

Such varying degrees of hardenability affect the development of cracks in different ways. In full hardened shank tools of small cross section, longitudinal cracks usually develop, where in tools of larger cross section, which do not harden throughout, bow-shaped cracks occur.

The U10 (1.0% C) and U12 (1.2% C) specimens investigated were chosen so as to bring the experiments as close as possible to actually observed cases of cracks that develop during heat treatment of shank tools in industrial practice.

The work was done on 60 mm. long specimens of square sections with respectively five, eight, 10, 13, 15, 20, 27 and 35 mm. sides. The steel of the melt investigated contained 1.01% C, 0.36% Mn, 0.20% Si, 0.031% P, and 0.027% S and, as delivered, had a hardness of 187 Brinel points. Its microstructure was a mixture of spheroidite and pearlite. Hardenability was measured by the depth of the case hardened to at least 60 Rockwell C points.

The experiments were carried out in the following manner. Specimens, suspended by the hole drilled at one end, were heated in a salt bath to temperatures ranging from 750 to 1000 C., then cooled by vigorous agitation in water at 20 C. The specimens were heated in salt bath based on a rate of 35 seconds/mm thickness holding time. After quenching, the specimens were immediately checked for cracks. This inspection was made again after a lapse of 24 hours. To limit the time the

* Translated by Henry Brutcher, P. O. Box 157, Altadena, California.
Abstracted by Fred Heinzelman, Jr., member, METAL TREATING Publication Committee.

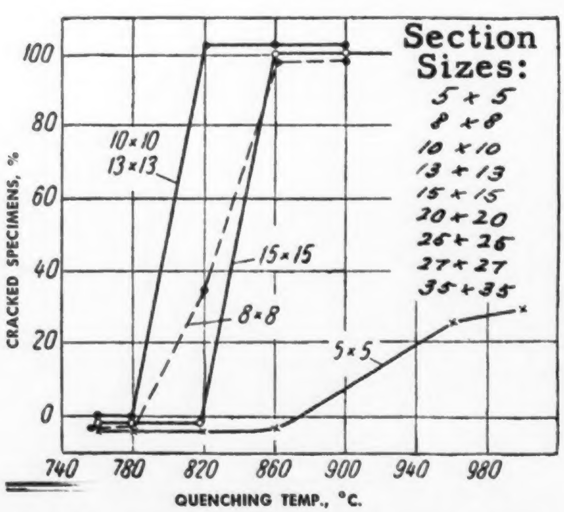


FIG. 1. Effect of quenching temperature on development of cracks in full-hardening specimens of U10 tool steel; figures on curve indicate the specimen sections in mm.

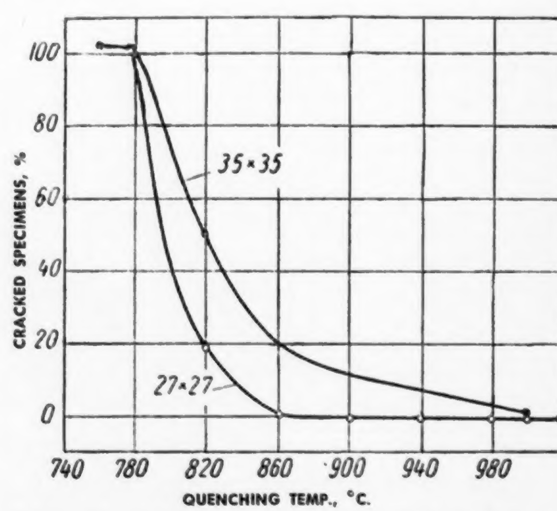


FIG. 2. Effect of quenching temperature on cracking of not fully hardening steel U10 specimens.

# N DEVELOPMENT

## of Cracks in Tools

specimens remained in the as quenched state, they were tempered 180-200 C. after the 24 hour period.

These experiments on specimens of various cross sections made it possible to determine the effect of the quenching temperature on the development of cracks. The curves obtained for the number of cracks on the quench temperature can be divided into three different types.

The first type (Fig. 1.) is characteristic of specimens with cross sections smaller than 20 by 20 mm. (0.8 by 0.8 in.) The curves obtained indicate that, within a certain range of heating temperatures, the tendency of the steel to develop cracks is directly proportional to the quenching temperature. The higher the latter, the larger the percentage of specimens with cracks. A change in the cross section of the specimens shifts both the temperature of the beginning of crack development and the temperature which causes the development of cracks in *all* specimens.

The specimens in which this type of dependence was observed had a core hardness ranging between 69 and 65 Rockwell C and hardened fully whenever their cross section was 5 by 5, 8 by 8, 10 by 10, or 13 by 13 mm. The specimens of a 15 by 15 mm. section did not harden throughout but had a core hardness between 46 and 47 Rockwell C. Longitudinal cracks were discovered on these specimens.

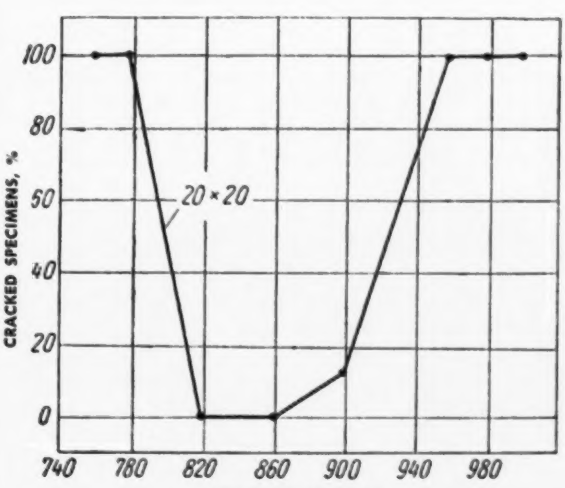


FIG. 3. Effect of quench temperatture on cracking of 20 by 20 mm. (0.8 x 0.8 in.) specimens, not fully hardening at low, but fully hardening at high quench temperatures.

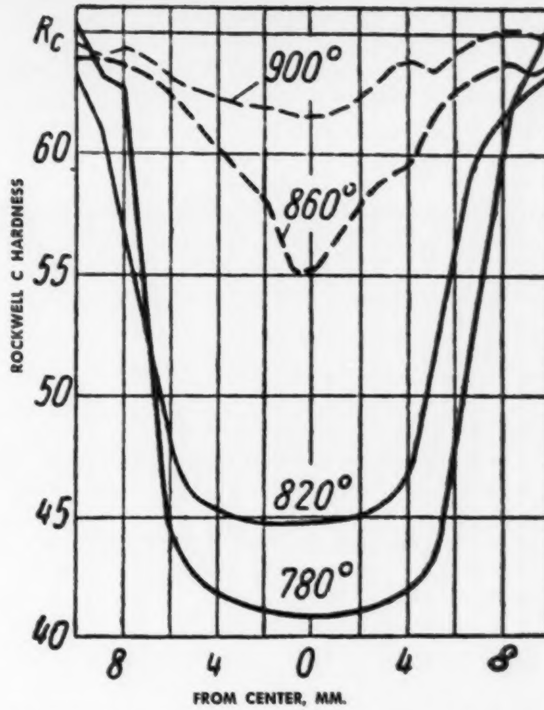


FIG. 4. Hardness distribution across 20 by 20 mm. specimens as function of quenching temperature. U10.

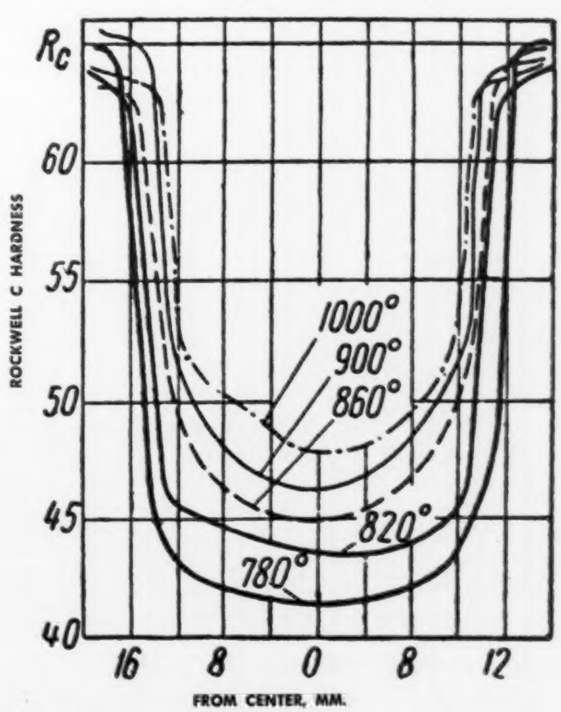


FIG. 5. Hardness distribution over 35 by 35 mm. section of U10 specimens as function of quench temp.

## EFFECT OF HARDENABILITY • • •

*Continued from page 13*

Curves of the second type (Fig. 2) represent the dependence of crack development on the quenching temperature for specimens of sections exceeding 20 by 20 mm. These curves differ from those of Fig. 1 in that the maximum crack development here corresponds to quenches from the lower limit of heating temperatures, or from 760-780 C. With increasing quenching temperature, the number of specimens with cracks does not increase as in the case of smaller section specimens, but decreases.

Overheating of the steel quenched from 860-940 C. did not cause cracks in the specimens. This temperature range proved less dangerous in regard to cracking than 760-780 C.

After a quench from 780 C. the hardness of the 27 by 27 and 35 by 35 mm. specimens remains high in the surface zone and their core hardness lies between 40 and 41 Rockwell C. It should be noted that these specimens did not harden throughout and that the core hardness is below 46 Rockwell C.

In such specimens, bow-shaped rather than longitudinal cracks developed. The bow-shaped cracks generally developed at the drilled hole end of the specimen. Occasionally, such cracks appeared at the opposite end of the specimens, but, in these cases, the cracks did not come to the surface, and were visible only if the hardened upper layer had been removed.

The third type of curves representing the dependence of the development of cracks on the quenching temperature shows two crack maxima (Fig. 3). This type was obtained from specimens of cross sections intermediate between those producing the curves of the first (Fig. 1) and the curves of the second type (Fig. 2), such as for specimens of a 20 by 20 mm. cross section. The left maximum represents this dependence obtained for specimens which did not fully harden, and the right maximum for specimens which did.

The crack development curve obtained is related to the core hardness of the specimens in the same way as was observed before in specimens yielding curves of the first and the second type. This is illustrated by the curves of hardness distribution across specimens of 20 by 20 and 35 by 35 mm. sections (Fig. 4 and 5). After a quench from 780 C., the Rockwell C hardness of the core of a 20 by 20 mm, specimen is 41 (Fig. 4) and corresponds to the core hardness of specimens which develop bow-shaped cracks. This is why the first maximum of the curve in Fig. 4 corresponds to specimens which do not harden throughout and at the same time develop bow-shaped cracks.

With the quenching temperature exceeding 780 C. the case hardness of the specimens remains practically constant, within the 64-65 Rockwell C range. During this process, the core hardness increases with quenching temperature. In specimens of a 20 by 20 mm. section, quenched from 900 C., the core hardness becomes equal to the hardness of the surface zone, enabling the specimens to harden throughout. The temperature from which the specimens harden throughout is one at which steels become very much overheated. This is why they develop longitudinal cracks. This factor explains the second maximum on the curve of crack development in 20 by 20 mm. section specimens.

In specimens of a larger cross section (35 by 35 mm.), the core hardness also increases with temperature. After a quench from 950 C., it reaches 46-47 Rockwell C (Fig. 5). Thus, in the case of these specimens, the conditions governing the development of longitudinal cracks were not reached, and the curve has only one maximum. The hardness in 27 by 27 mm. specimens changed with increasing quenching temperature in a similar way. Even after a quench from 1100 C., the core hardness was only 50 Rockwell C.

Analysis of the experimental data shows that, in U10 and U12 tool steels with the case hardness lying within the 62-65 Rockwell C range, the type of the crack development is determined by the core hardness. If the core hardness lies within the 40-46 range, the specimens develop bow-shaped cracks. However, if the core hardness rises above 61, longtitudinal cracks develop whenever the steel becomes overheated.

The development of cracks in specimens matches that actually observed in shank tools, with small corrections for variations in the cross sections of the specimens.

By controlling the core hardness of a tool, it is possible to prevent the development of bow-shaped cracks. In order to accomplish this, it is necessary to increase the core hardness to 46 and higher. As was illustrated by the experimental increase of the core hardness above 40-46 Rockwell C, the number of specimens developing cracks drops to zero.

In the U10 and U12 steels of 20 by 20 and 25 by 25 mm. cross sections, it is possible to increase the core hardness effectively by raising the quenching temperature to 800-820 C. This temperature does not entail any considerable overheating, and can be permitted for heating tools of these dimensions. For specimens of larger cross sections, raising the core hardness to 46 requires a quench from 860 C. This temperature results in overheating and cannot be used for quenching the tools.

Increasing the core hardness by the use of U12 steel of higher hardenability, in manufacturing tools of heavier sections, is recommended.

In all cases and as an additional safeguard, immediate tempering after the quench proves to be effective. During the particular experiments, it was observed that cracks developed not immediately after the specimens were cooled to room temperature, but five to 20 minutes later.

Development of longitudinal cracks greatly depends on the degree of overheaing of the steel. The higher the quenching temperature, the more specimens are affected by cracking.

*Concluded on page 35*

# NEW FURNACE HEAT TREATS STAINLESS STEEL FOR THE B-70's

**CHRISTY LAMBESIS, P. E.**

**Plant Engineering**
**North American Aviation, Inc.**
**Los Angeles, Calif.**

A GANTRY FURNACE recently placed in operation by North American Aviation, Inc., Los Angeles, is believed to be the largest and most modern facility used in the heat treatment of heat resistant stainless steels.

It rides on rails above a pit containing a draw furnace and two quench tanks, to which it can be coupled with a special collar when parts should be transferred to a drawing or quenching chamber in a protective atmosphere. Its work area is eight feet in diameter and 30 ft. high. When coupled with the draw furnace, it becomes part of an airtight compartment which is eight ft. in diameter and 60 ft. tall.

Installation of the big gantry furnace and related processing facilities was made necessary by specifications for B-70 Valkyrie triplesonic bombers, since an investigation disclosed that no heat treating equipment available in the United States could satisfactorily handle parts with compositions and dimensions indicated for B-70 production.

Made for North American by Lindberg Engineering Company, Chicago, both the gantry and its draw furnace mate have provisions for electrical heating. Among other things this saves much of the cost of plumbing that is ordinarily required to use a fuel such as natural gas in either structure.

With its heating facilities, the gantry can heat a maximum load of 10,000 lbs. to 2050 F. within ±10 F. The draw furnace holds tolerances of ±5 F. at temperatures ranging from 375 to 1450 F.

Furnace accessories include a 10,000 lb. Whiting two-speed, three-runway bridge crane, a Lindberg high nitrogen generator, Minneapolis-Honeywell master-slave instru-

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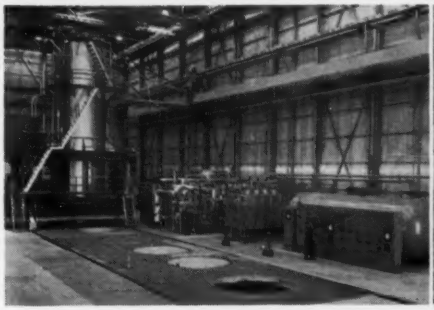

General view (left) of North American's new gantry furnace. High nitrogen generation facilities can be seen at right. Pictured (right) is a subzero chamber for North American's new heat treating setup prior to being lowered into foreground pit where it is now located.

Quench tank for North American's new heat treating setup is shown here just outside of the building where it is now installed in a reinforced concrete pit.


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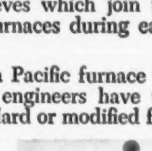
Designed for rapid-production heat treating, large missile components are quickly transferred from furnace to furnace to quench tank, under precision controlled atmospheres and temperatures. Heated parts are shielded from air by pneumatically actuated sleeves which join the draw furnaces and quench tanks to the gantry furnaces during each successive phase of the heat treating process.

HUGE • SMALL • STANDARD • SPECIAL • There's a Pacific furnace for every heat treating requirement because Pacific engineers have the extensive, proved experience to recommend a standard or modified furnace, or to design a special new one, for any heat treating need known to industry. And as new techniques and processes become necessary, you can depend on Pacific's competent research and development staff to supply the logical, prompt solution. A qualified Pacific field engineer is always available to discuss any heat treating job in your plant... simple or complex, for plant or laboratory...without obligation. Phone or write for complete data on Pacific's highly diversified heat treating capabilities.

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# The apprentice corner . . . . .

The following is an edited report of an information letter released by the American Gas Association to new industrial engineers who have not had any training in heat treating. While a great deal of the material covered will be information with which readers of this journal are intimately familiar, its content will serve as an excellent primer for some. The report was prepared by Stanton T. Olinger* and issued by AGA chairman William R. Gartz**.—*The Editor.*

## Modern Fundamentals of the Heart Treatment of Steel

BY

**STANTON T. OLINGER**

FOR A GOOD MANY YEARS our civilization has been based on the use of steel. A good portion of the industrial gas sold by any gas company is going to be used by industry to manufacture, form, and heat treat steel. (Figures 1, 2, and 3).

Fortunately, the metal iron when combined with carbon, a nonmetallic element, or other metals acquires physical properties which can be varied to meet the needs of our civilization. Just why this is true is not completely clear and much research must still be carried on before we are sure of the reason. However, carbon is the principal agent in creating these desirable properties and we will confine this discussion to its effect.

First, let us define heat treating. It consists principally of heating the object to an elevated temperature and then bringing it back to either room temperature or below. This treatment is basically for two purposes; either to soften the material so that it can be machined or to harden it so that it will resist wear.

Without this ability to harden steel we would be unable to build modern machinery or automobiles. Our everyday tools such as hatchets, saws, and drills would be useless for practical purposes.

As stated, carbon is the principal element causing different hardness and this discussion will be confined principally to its effects.

Steels having different carbon contents will have different physical properties even in the fully annealed state, and wide variations when hardened. For example, a steel of 35 points carbon will be softer in the fully annealed state than a steel having 100 points of carbon. By points is meant hundredths of a percent, and 100 points is 1.00%. (Figure 4).

This variation of physical properties, because of chemical composition and physical treatment, is fairly

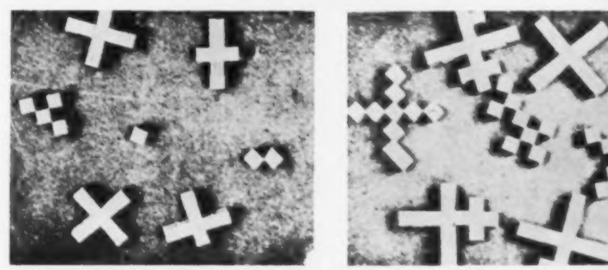


Fig. 1. Crystals beginning to form in molten metal.

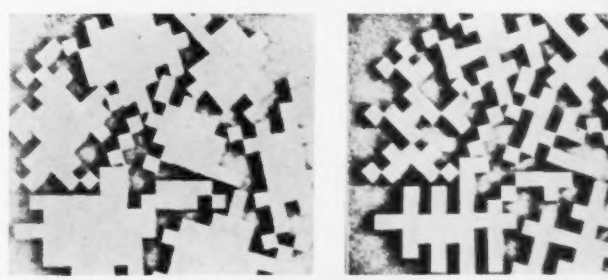


Fig. 2. Further crystal formation showing grains beginning to form.

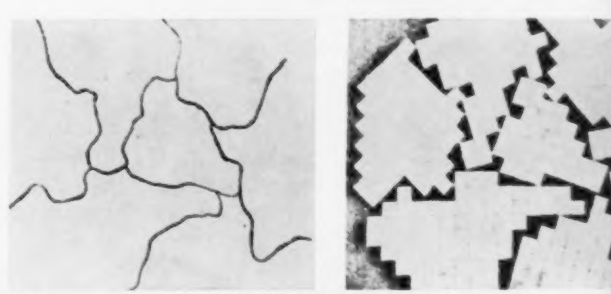


Fig. 3. Crystals almost joined and typical grain pattern in steel.

* The Cincinnati Gas & Electric Company
** People's Natural Gas Company, Pittsburgh, Pennsylvania

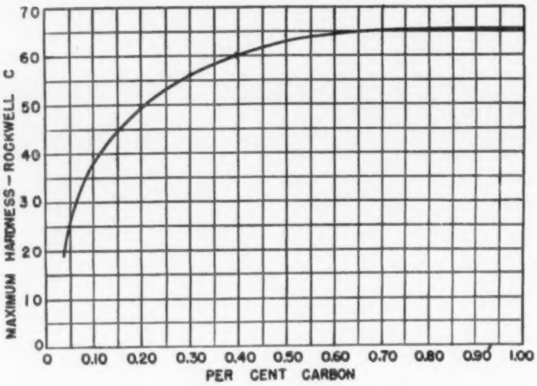



Fig. 4. Maximum hardness obtainable with various per cents of carbon.

complicated but once you understand the principle it falls into a general pattern.

Probably the most useful tool in the hands of the metallurgist is the iron carbon diagram (Figure 5). It was first drawn by W. C. Roberts-Austin whose work was published in 1897. Changes have been made since that time but the lower left hand portion is today substantially as he drew it then.

If we will consider three steels having a carbon content of 13, 31 and 43 points and other elements the same, we can see how the iron carbon diagram is formed. By heat treating these steels and raising them to various temperatures and quenching them in water, we find that they all begin to harden at the same temperature — approximately 1320 F. — but that the maximum hardness is reached at various higher temperatures. The 13 point steel had to be raised to 1575 F. before it reached maximum hardness. The 31 point steel reached its maximum hardness at 1490 F., while the 43 point steel was completely hardened at 1450 F.

A line which can be drawn by plotting the above points indicates that steels which are similar except as to carbon content all begin to harden at about the same temperature, irrespective of their carbon content. This temperature of initial hardening is about 1320 F. The other line shows that the lowest temperature for full hardening changes with carbon content. The higher the carbon the lower the temperature. Thus we have in this simple manner shown the construction of part of the iron carbon diagram.

The iron carbon diagram shown on Figure 5 only goes up to 2% carbon, while other diagrams can be found going to 5% or 6% carbon.

It will be observed that as the carbon content of the steel increases, the temperature of full hardening becomes lower until at .83% the temperature of full hardening coincides with the temperature of initial hardening.

If we examine a definite steel and heat treat it in various ways, we will be able to establish a pattern which will explain how and why the steel becomes hard or soft. Examination by means of microscopic slides will help to explain the process.

For an appropriate example, let us choose a suitable steel such as a 56 carbon steel of the following composition:

| | |
|---|---|
| Carbon | 0.56% |
| Manganese | 0.78% |
| Phosphorus | 0.017% |
| Sulphur | 0.028% |
| Silicon | 0.22% |

This steel, which is soft initially, can be hardened by heating it to 1500 F. and then cooling it rapidly by water quenching.

In order to measure physically the hardness, we might use a file, but such a method would be crude. Preferably, we should use a Rockwell Hardness Tester. Our 56 point steel, when tested on this machine, shows an initial hardness of 10 Rockwell-C (10 Rc). (Figures 6, 7, and 8.)

Instead of heating the steel to 1500 F. as mentioned earlier, suppose we only heated the steel to 800 F. and quenched it. What change would have occurred in the steel? None. Suppose we heat the steel to 1200 F. before quenching it, what would have happened? Again the change would have been negligible. Its hardness is still 10 Rc and under the microscope it still looks like Figure 8.

The dark areas are pearlite and they contain the carbon which is in the steel. (Figure 9.)

The 56 points of carbon in our steel is not present as carbon, but as a compound $Fe_3C$. This compound occupies about 15 times as much space as carbon, so that 0.56% carbon, present as iron carbide, amounts to 15 times that much or 8.4% of the steel. In considering a steel containing 0.56% carbon, we must visualize a material which rather than consisting of 0.56% carbon and the balance metal, consists really of 8.4% iron carbide and the balance metal. This iron carbide is distributed in a matrix of iron, called ferrite, the two together being called pearlite.

Two other constituents of hardened steel with which heat treaters must become familiar are Martensite 65 Rc and Austenite, a compound not found normally at room temperatures. The pearlite is called lamellar because it occurs in thin plates or sheets. Sometimes it occurs in other forms such as spheroidal.

Both pearlite and ferrite are soft and in order to conduct this study we must increase the temperature to 1320 F. before quenching. When we measure the hardness, it has risen to 19 Rc, and a new material has appeared. This is Martensite. It is formed in the following manner. When the steel was heated to 1320 F. some of the pearlite formed a new structure. The

carbide and the ferrite with it went into solution in each other and formed a new crystal structure, a solid solution of carbon in iron existing at high temperature as crystal grains called Austenite. This Austenite is soft, but when the steel was quenched, the Austenite, in cooling, transformed to the new constituent Martensite, which is very hard. (Figures 10, 11, and 12.)

Much speculation and vast amounts of work have been done to determine why some metals and their constituents are hard and others soft. Possibly the best explanation is that when the piece of metal is stressed so that it deforms, these grains deform in a special manner. Within each grain, layers or blocks of the metal slide past each other in somewhat the same manner as do the cards in a deck of cards when pushed sideways. When this sliding takes place easily, then resistance to deformation is low—in other words the metal is soft.

Any resistance to deformation increases the hardness and when carbon is added to iron, the resultant steel is somewhat harder than iron because the grains do not slip as easily. Further, the slipping of grains meets some resistance at the grain boundaries and if the grain is fine, slip will be obstructed considerably. In Martensite, the above causes are present and also the quenching has probably set up stresses which allow slip to take place only with the greatest difficulty.

We see that our 56 carbon steel quenched from 1320 F. has three constituents, a small amount of Martensite, which is hard, a large portion of the original pearlite, which is soft, and all of the original ferrite, also soft.

If we raise the temperature before quenching of our steel to 1340, 1380, 1450, we find increasing amounts of our pearlite being transformed to Martensite. At about 1450 F. all these changes have taken place and we say the hardness is complete. The hardness now is 64 Rc and the steel is in a fully hardened state.

What will happen if the steel is heated to a similar high temperature and then instead of being quenched in water, is cooled slowly?

To study this situation, let us continue with our 56 carbon steel, but reverse the procedure. If we allow our steel heated to 1500 F. to cool slowly by shutting off the burners and take out a piece at 1450 F. and quench it, we will find the hardness the same as the 1500 F. The steel must cool to 1325 F. before there is any change. Our steel is one or two Rc points lower and a microscopic examination will show a small amount of ferrite. The presence of the small amount of ferrite causes the resulting steel to be slightly softer than in the fully hardened state. Further dropping of the temperature before quenching shows decreasing hardness and large amounts of ferrite are visible under the microscope until at 1225 F. pearlite appears.

What happened on heating has been reversed in this slow cooling; namely that while on heating, pearlite was the first to transform to Austenite, followed by the absorption of the ferrite, on cooling, the ferrite separated first, to be followed by formation of pearlite.

The full transformation back to our original steel is not complete until we have dropped 25 F. further to 1200 F. The hardness is now 10 Rc, the same as when we started. Further dropping of the temperature will have no effect and the steel will remain the same as it was at 1200 F.

A question arises when we consider the facts brought out in our experiments with the 56 carbon steel. It started to harden at about 1320 F. and was fully hardened at 1450 F., a rather narrow range. Would other steels of different carbon content harden at the same temperatures? Rather than run through all the experiments again, it suffices to say that a lower carbon steel, other elements being the same, will start to harden at about the same temperature. Although the final hardness will be lower than our 56 carbon steel, the full hardening temperature will be above 1450 F. and the lower the carbon, the higher the final temperature for complete hardening.

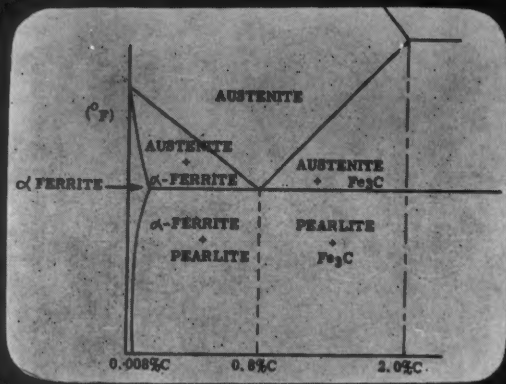
In the above paragraphs we have used the word quenching without any particular definition. It should be explained that there are many variations in hardening due to various methods of quenching. Quenching may be done in water and the steel cooled rapidly. Figure 13 shows the so-called S Curves which show that steel must be quenched quickly, avoiding the nose of the S curve if we wish it to be fully hardened to Martensite. If the time of cooling is delayed we normalize this steel or anneal it and secure the composition shown.

Suppose now we try the effect of slower cooling by using oil instead of water. This will lengthen the period for cooling. In many cases it is necessary, as a fast quenching in water may crack the piece.

By trying an oil quench on a half-inch round that gave 60 Rc in water, we find that our hardness has dropped to 30 Rc. In the case of a 5 in. piece it has dropped from 24 Rc to 18 Rc. It is apparent from these results that our steel has hardly hardened at all.

What can be expected from variations in size? Figure 14 shows the effect on hardening of varying the diameter. It would be natural to expect that if we heat treat progressively larger pieces of steel our hardness would decrease somewhat on the surface and more noticeably in the center. A larger piece will not cool as rapidly but we would get more of an annealing effect. A steel that will harden to 60 Rc in a ½ in. round will only harden to 24 Rc on the surface when the size is increased to five in. The center of the same five in. round will be still softer, possibly about 20 Rc.

From the above it can be seen that by changing the quench, or the size, we can vary our hardness. Another common method is to change the composition. Figure 15 shows what happens to the nose of the S Curve by adding alloy. We can now quench in oil, where water would not be utilized as it might distort or crack the part. Not only by changing the carbon can we change

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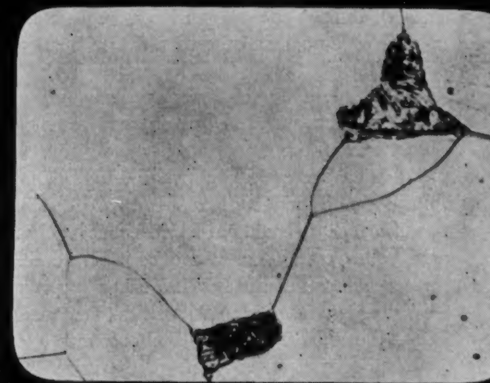

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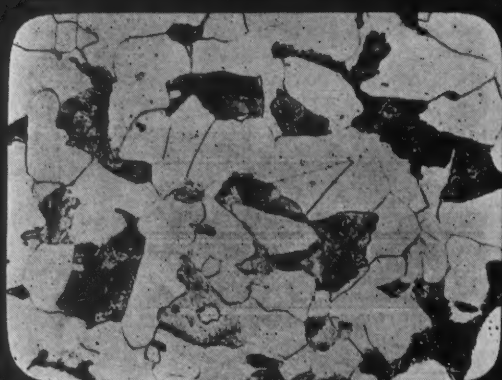

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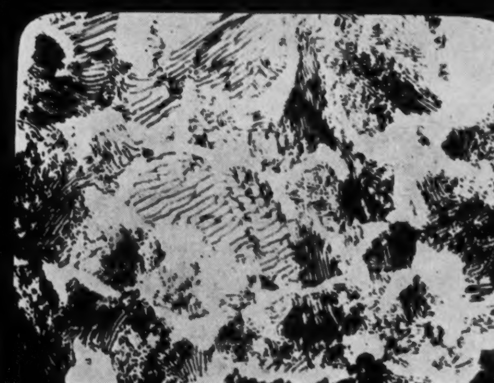

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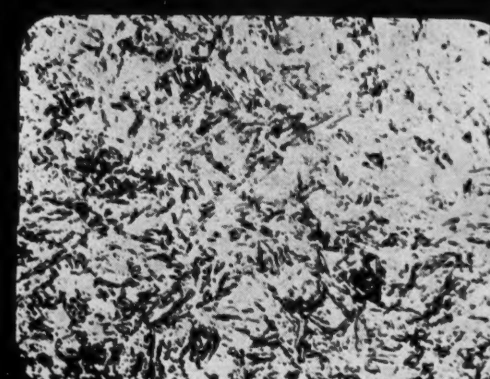

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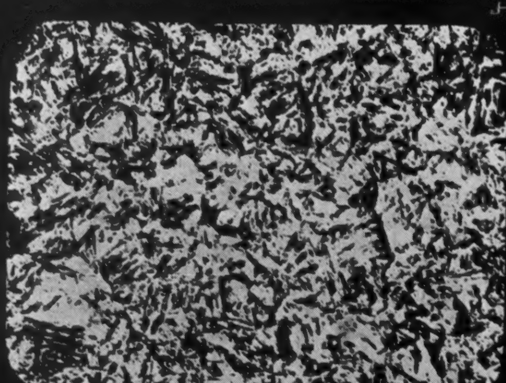

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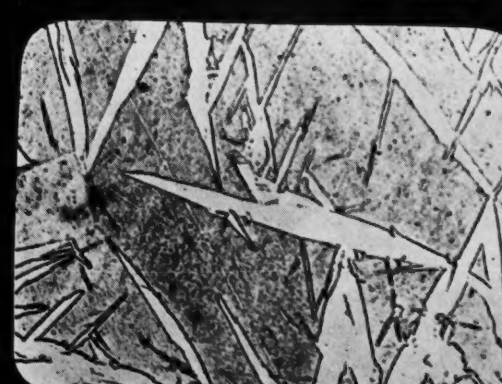

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Fig. 5. Simplified Iron Carbon Diagram.

Fig. 6. .17% carbon steel annealed from 1700 F.

Fig. 7. .39% carbon steel annealed from 1700 F.

Fig. 8. .56% carbon steel annealed from 1700 F.

Fig. 9. Pearlite in a eutectoid steel.

Fig. 10. 2340 steel oil quenched showing Martensite crystals.

Fig. 11. 1040 steel water quenched showing Martensite crystals.

Fig. 12. Martensite crystals.

our hardness, because other alloying elements will have a powerful influence. The ones most commonly used are nickel, chromium, vanadium and molybdenum.

Suppose we had some alloying element in the steel besides the carbon such as chromium and vanadium. Such a steel will harden when quenched in oil and our ½ in. round will be fully hardened to say about Rc 55 and the five in. piece to about 35 Rc.

From this study it is apparent that when a steel is heated to above its critical temperature and then cooled slowly, it is soft. This process is called annealing, but we wish to discuss another similar process called tempering. Tempering is important because it can be controlled closely and can be used to give hardened steel various important physical properties. Tempering consists of reheating the hardened steel to various temperatures below the hardening range. If the temperature to which the steel is reheated is low, 300 F. to 400 F., then the hardness will be lowered only a little. As the reheating temperature is raised, the hardness is lowered markedly until at temperatures of 1200 F. to 1300 F. the reheated steel is nearly as soft as annealed steel.

This is tempering or drawing. Its purpose is not to draw or temper the hardness, but to toughen the steel. Hard steels are generally brittle and a lower hardness will usually increase the toughness.

We will now try to understand why this is true by referring back to our 56 carbon steel that was hardened to 64 Rc. Its structure was Martensite. (Figures 10, 11 and 12.)

If this hardened steel is now tempered at 400 F. for one hour, the hardness falls to 56 Rc, and although an examination by the microscope will show no visible change, there is an improvement in toughness. For some jobs this is all the tempering necessary.

As we progressively increase the drawing temperature and finally reach 900 F. the hardness will have fallen to 39 Rc. The needles of Martensite are less sharp.

We have mentioned toughness several times in discussing tempering, and we need some method of determining the toughness of a steel. A common method is to determine its resistance to breakage under impact.

Normally, hardening operations consist of quench-

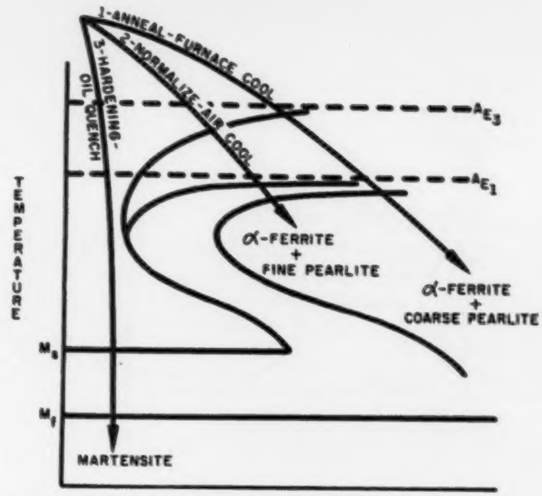
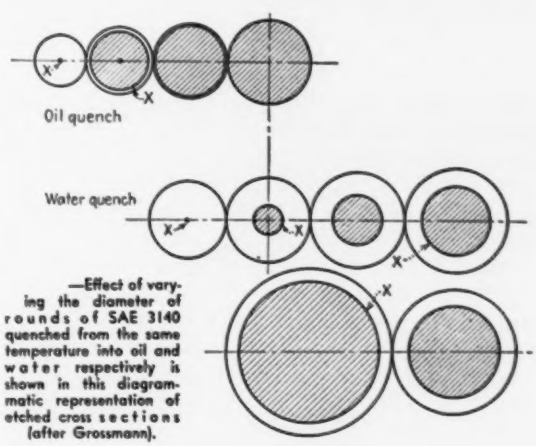



Fig. 13. Time and temperature S curves.




—Effect of varying the diameter of rounds of SAE 3140 quenched from the same temperature into oil and water respectively is shown in this diagrammatic representation of etched cross sections (after Grossmann).

Fig. 14. Effect of various diameters on hardening.

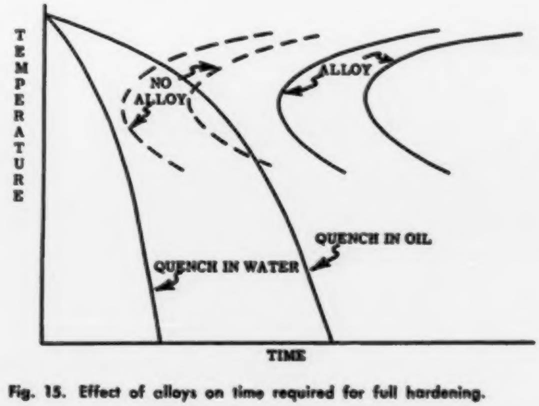



Fig. 15. Effect of alloys on time required for full hardening.

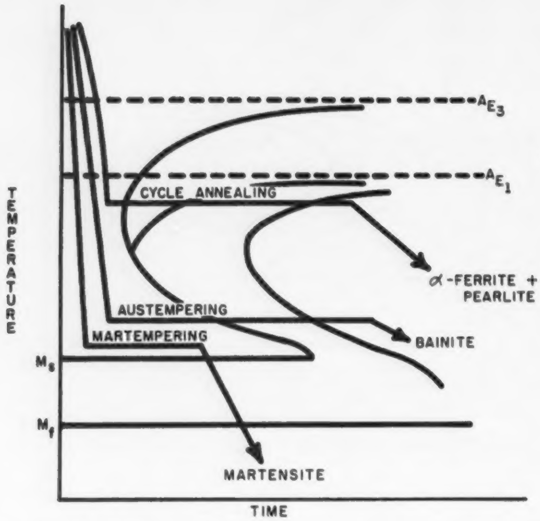



Fig. 16. Various structures that can be obtained by quenching at elevated temperatures.

ing steel from hardening temperatures into a liquid which is at room temperature. However, valuable results may be obtained in many cases where the quench is at elevated temperatures. (Figure 16.) If the temperature to which it is quenched is high, over 1200 F., and the steel is held at this temperature for a period of time, pearlite will be formed. Lower temperatures will form other compounds. The valuable properties secured with this method of treatment are a marked improvement in ductility with little loss of hardness.

Often it is desirable to give steel a hard surface so that it will wear well, but we do not want the center hard. By leaving it soft, our steel will be tougher and stand shock better. A typical example of this is a cam, which must have a very hard surface to wear well and yet must be very tough to resist the impacts it receives in service.

Low carbon steels are tough, while high carbon steels may be made very hard by heat treatment. With this in mind it is easy to see that a piece having a tough low carbon center and a high carbon surface would give the desired combination of properties. The whole piece would be heat treated, with the result that the surface would be hard, yet the piece as a whole would resist breakage because of the tough core.

To secure the above properties, we pack a piece of low carbon steel in a material consisting largely of carbon, or place it in an atmosphere having carbon potential and heat to an elevated temperature of approximately 1700 F. The carbon penetrates the steel and in time it will be found that the surface layers of the steel have absorbed substantial amounts of the carbon, so that the low carbon steel which originally contained 15 points of carbon, now contains in its surface 120 points.

This carbon concentration falls off rapidly beneath the surface of the steel and the time of carburizing, and in consequence, depth of penetration is controlled by the length of the carburizing process. Time may vary from one hour to 72 hours.

The 1700 F. temperature is largely used since at this temperature the steel is Austenitic and absorbs carbon readily.

After the absorption of the carbon, it is necessary to harden the steel. Since our core is still low carbon and won't harden, we have to remove the piece from our carburizing medium quickly and quench it. In some cases it is advantageous to slow cool after carburizing and reheat it to 1450 F. for quenching.

Cyaniding, another method of case hardening, consists of immersing the steel pieces in a molten salt bath or a carburizing atmosphere containing ammonia for a short period. This puts a thin case on the part, usually only a few thousandths thick. This case consists largely of carbon with a little nitrogen.

Nitriding is another case hardening process where a nitrogen case is secured by heating the steel to about 900 F. in an atmosphere consisting solely of ammonia. A very great advantage of the nitriding process is that the hardening operation consists merely of heating in ammonia gas at 900 F., and then cooling slowly in the furnace, without any further heat treatment. No scaling occurs since the steel is not exposed to air at elevated temperatures and so pieces can be finished to size before heat treating. There is no distortion due to the low temperatures and the hardness obtainable exceeds anything possible by other known methods of steel treatment. • • •

*concluding . . .*

## *Modern Fundamentals of Heat Treating of Steel*

## CARBON CONTROL • • •

*Continued from page 11*

CFH flow of natural gas is insufficient to compensate for the change in generator dewpoint. As soon as the flow was adjusted to 5 CFH, proper control was restored. This would indicate a sensitive response to changes in both generator dewpoint and gas additives.

A +20 F. generator carrier gas has been found to be suited for most cycles. An evaluation of results would indicate some unreliability in manual dewpoint measurement as a basis for control, although frequent checks are encouraged. Gas analysis of each load would be impractical, but with a recording fractometer or other gas analysis equipment now available, positive correlation on a pilot basis would be very helpful. Investigations of this nature are being made on production heats.

One characteristic of dewpoint measurement at elevated temperatures is the necessity of increased attention to filtering, and frequency of cleaning of the sensing system. Fortunately, cleaning is a very simple operation, and, if necessary, can be done without interrupting the carburizing cycle.

In recent months, several metallurgists have initiated their own development programs. Because of time factors involved in performance testing these various applications, very few production processes have adopted this practice. Of those who have done so, it might be reasoned the initial interest was occasioned by either necessity or economy. Applications involving extreme abrasive or wear resistance have been carburized at temperatures of 2000 F. or higher for several years. Modified tool steels or stainless steel analyses with carbide forming elements are generally utilized, and advantage made of the additional carbon solubility at the higher temperatures. Rich atmospheres are used in an attempt to build up a massive carbide network. It is possible to obtain hardness readings in excess of 70 Rc with this practice.

*Concluded on page 32*


MOBILIFT
MOBILIFT




HEAT TREATING
SHOULD YOU DO IT YOURSELF?

# Heat Treating Case Histories — Case No. 5

## FIRST 50 KW WITH DUAL FREQUENCY

MOST INDUCTION HEATING UNITS installed around the nation operate in the low frequency range with a maximum of 500,000 cycles. This limitation has caused heat treating plants to hope that one day some manufacturer might produce a machine that would offer the most versatile range for the largest number of medium and heavy duty requirements. This suggested a machine capable of operation between 200 and 450 kilocycles with variable output up to 50 KW, possibly incorporating provision for operating in the low megacycle frequency range as well.

Two firms decided that it was worth a real try because the benefits to industry could be substantial. Induction Heating Corporation of Brooklyn, New York, and Bennett Heat Treating Company, Inc. of Newark, New Jersey, pooled their engineering talents and heat treating know-how for many months, and finally have come up with the answer.

To meet the challenge, Bennett asked Ther-Monic to design and build for them a single 50 KW machine with both high and low frequency ranges interchangeable, from 200 to 450 kilocycles. As a result, Bennett may be the first firm in the United States able to select the precise frequency range best suited to every type of work with which the modern job shop heat treating plant is required to contend.

What follows is a first report on accomplishments and benefits to date:

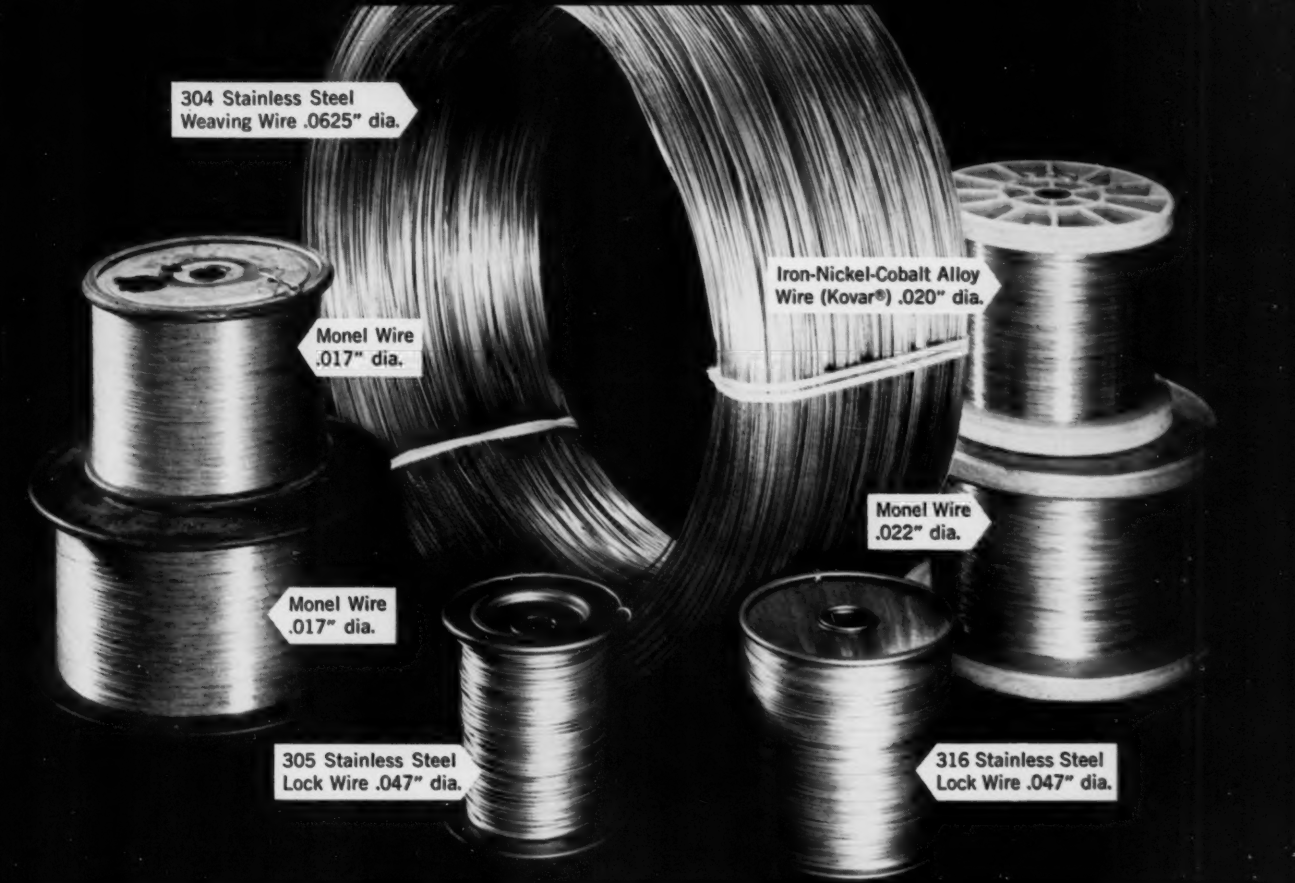
On thin cross sections results have been amazing. The high megacycle frequency range was employed for heating items where thin cross sections were encountered, or where minimum skin heating effects were desirable. Among the items processed were high precision small and medium sized gears. It was thought that because of the tendency for induced current of megacycle frequency to race on the surface, a thin case hardness could be imparted to the fine teeth without damage. On examination, the hardness pattern did follow the contour of the gear teeth from face to root, and appeared similar to those produced by conventional case-hardening methods. *Unlike the conventional methods, however, only the surface was heated by this frequency, therefore practically no change in the gear dimensions occurred.*

Heating cycles were shorter than anticipated, making it necessary to employ a heat timer with 1/100 sec. sensitivity. In case of extremely fine tooth gears, the hardening temperature was reached in only one fifth of a second.

On straight run standards it was found that most of the regular induction hardening jobs could be processed with a frequency of about 300 kilocycles. Again, output increased substantially because of the faster heating with less penetration. When deeper heating was desirable, output of the equipment was reduced and the heating time itself was extended by a few seconds.

In many instances, Bennett found, quenching may not be necessary.

*Concluded on page 32*




# How would you anneal these 5 types of alloy wire?

The various types of alloy wire in this photograph are manufactured for specialized applications by the Riverside-Alloy Metal Division, H. K. Porter Company, Inc. They range from stainless steel, for aircraft industry use, to monel metal and an iron-nickel-cobalt alloy with thermal expansion characteristics suitable for sealing to hard glasses. Annealing temperatures range from 1450 to 2150 F, close control being necessary to maintain wire quality, measured by elongation, grain structure and tensile strength. The wire is annealed continuously—normally in a disassociated ammonia atmosphere.

Experience has proved that electric furnaces equipped with GLOBAR® silicon carbide heating elements offer the cleanliness and capability for precise temperature control needed in this operation. The GLOBAR elements easily provide the maximum 2150 F heat—in fact, can be used with safety to above 2750 F. One of the furnaces used, with 13½" thick walls of refractory insulating brick, has required no maintenance of the lining over a 10-year period—pointing up the mild conditions to which insulating brick are subjected with this type of heat. With the low heat capacity of the insulating brick, it is possible to drop temperatures rapidly in going from the high to low end of the range.

The many advantages of heating with GLOBAR elements, as illustrated in this particular case, often more than cancel out possible differentials in Btu costs between electricity and other fuels. Why not investigate with your furnace builder—or write to Refractories Division, Globar Plant, Dept. MT-41, Niagara Falls, N. Y.

**For precise, economical electric heating**

**GLOBAR silicon carbide heating elements**

- Shipped from stock or within two weeks.
- Temperatures from 1400 to 2800 F, precisely controlled, independent of atmosphere.
- Easily replaced from outside without waiting for furnace to cool.
- "On line" operation for many applications—no transformer necessary.
- Elements 4" to 105" in length.
- For greater economy in heat treating, brazing, forging, melting and sintering.

*For latest advances in silicon carbide heating elements... count on*

**CARBORUNDUM®**

For further information circle No. 78

# About People.....

## American Steel Appoints Stone Chief Metallurgist

The appointment of Harold C. Stone as chief metallurgist has been announced by American Steel Treating Company, Crystal Lake, Illinois. Stone will direct all activities of the metallurgical laboratory and will be responsible for all heat treating specifications and quality control.

Harold C. Stone

Mr. Stone was formerly chief metallurgist for the Le Tourneau Westinghouse Company of Peoria. His activities there included control of the metallurgical and chemical laboratory, heat treating specifications, development work in the heat treating processes involving new and improved products.

A well known member of the metal treating industry, Stone's affiliations include the Society of Automotive Engineers, ASTM, and ASM.

## Changes at Hevi-Duty

Hevi-Duty Electric Company recently named Robert M. Palmer as overall field sales manager for the firm's industrial and laboratory furnace and oven divisions. Palmer, formerly manager of Hevi-Duty's Eastern Sales Office, will be in charge of all liaison activity between the field sales force and home office management personnel. He will operate out of the company's general offices located in Watertown, Wisconsin.

John C. Lavey will be the new district manager of Hevi-Duty's Eastern Sales Office located in Little Ferry, New Jersey. He had formerly been a sales engineer operating out of the same office.

E. H. Andrus was named field service manager by the firm. Andrus had formerly been staff engineer in charge of service and product development for the Fawick Corporation, Cleveland, Ohio.

Norman McDonald, former general manager of Ipsen Industries, Rockford, Illinois will function as a sales specialist in charge of sales promotion for Hevi-Duty's "Clean-Line" Automatic Heat Treat Furnaces. Both Andrus and McDonald will operate out of the firm's Watertown home office.

## New MTI Executive Secretary

H. R. Herington was recently appointed executive secretary of the Metal Treating Institute, filling the vacancy created when C. E. Herington became associated with Rex of Florida, Inc., (see page 30).

Mr. Herington brings to the Metal Treating Institute the benefit of the experience gained during the period 1955 to 1960 when he served in the capacity as assistant to the Executive Secretary. During that period he also served on the staff of METAL TREATING.

## Vacuum Society Prexy

Benjamin B. Dayton, technical director of Consolidated Vacuum Corp., a subsidiary of Bell & Howell, was recently elected president of the American Vacuum Society. He succeeds Wilfred G. Matheson of Sylvania Electric Products, Inc.

Dayton said one of the major events during his year in office would be a joint congress of the American Vacuum Society and the International Organization on Vacuum Science and Technology next October in Washington, D. C.

Dayton has been technical director of CVC since 1954. Previously, he was director of research and supervisor of the development and quality control department of CVC. He has a B.S. degree in physical chemistry from the Massachusetts Institute of Technology and an M.S. in applied physics from the University of Rochester.

Benjamin B. Dayton

In addition to the American Vacuum Society, Dayton is a member of the American Chemical Society, American Physical Society, and the Instrument Society of America. He is a past member of the executive committee and former chairman of the standards committee of the Committee on Vacuum Techniques, and has authored numerous articles for scientific journals.

## Stanwood Corporation Appoints Two Reps

Stanwood Corp., Chicago, has added two new sales representatives to its growing field sales force. Both men will handle the company's complete line of baskets, trays, carburizing boxes, retorts and other heat treating equipment.

Serving Stanwood customers in

*Continued on page 30*

## ABOUT PEOPLE • • •

*Continued from page 28*

Northern Indiana will be S. E. Flenner of the Elder Engineering Company, Michigan City, Indiana.

Lee F Grunkemeyer, Cincinnati, will handle Stanwood products in Southern Ohio.

### Foxboro Sales Expansion

To coordinate its worldwide sales activities in light of a growing volume of instrument sales, The Foxboro Company of Foxboro, Massachusetts, has added a marketing division which will serve its associated companies in England, Canada, Holland and Japan, as well as its United States market.

C. Schwarzler

Appointed vice president of marketing was C. Schwarzler who, as head of the new division, will be responsible for planning and directing the development of new market areas and disseminating Foxboro instrument engineering information throughout the world. He will also direct the company's sales promotion and publication activities.

Sales growth in the domestic market has been reflected by the appointment of H. O. Ehrisman as vice president and United States general sales manager. His primary responsibility will be the company's 61 branch offices in major industrial cities of the United States and related home office sales operations.

H. O. Ehrisman

Schwarzler has been associated with Foxboro for the past 26 years, being appointed export manager in 1944 and manager of international operations in 1955.

### Rex of Florida, Inc. Appoints Vice President

C. E. Herington, Editor of METAL TREATING, and former Executive Secretary of the Metal Treating Institute, is now associated with the new Florida commercial heat treating corporation, Rex of Florida, Inc., Fort Lauderdale, as vice president. In this capacity, Mr. Herington will direct the new company's sales and sales promotion activities.

C. E. Herington

Mr. Herington has been editor of METAL TREATING since its founding in 1950 and was executive secretary of the Metal Treating Institute since January 1951. His sales and sales promotion activities date from 1939 when he became associated with the former Meehanite Research Institute.

In 1950 he established his own advertising agency, and this agency originated and produced for six years the industrial direct mail for Crucible Steel Company of America.

Mr. Herington is also secretary-treasurer of the Foundry Facings Manufacturers Association.

# WHAT WOULD YOU DO?

a problem in labor arbitration taken from the files of the American Arbitration Association

## CASE OF THE EXTENDED VACATION

Millie T. had two weeks paid vacation coming during the summer of 1960. But the kind of vacation she had in mind required an extra week, so she asked the personnel manager whether it would be all right if she took the third week at her own expense. Looking at the vacation schedule, and taking into account orders at hand, the personnel manager said he couldn't okay the deal. But he suggested that if she telephoned during her second week of vacation he would let her know whether it was possible for her to have the extra time.

Millie went off on her vacation but didn't get around to calling until the middle of the third week. The personnel manager happened to be out at the time and she didn't even bother to leave a message. When she returned to work, she got a week off as a disciplinary penalty for her irresponsibility.

The union filed a grievance. "This is a case of rank discrimination," said the business agent. "Millie should have been permitted to take the third week off in the first place. The fact that you suspended her for a fourth week proves she wasn't as urgently needed as the personnel manager said."

The company answered that the vacation schedule was eased during the fourth week. "Besides," the personnel manager pointed out, "we have to keep the work force properly disciplined even if it turns out to be inconvenient for management."

**THE AWARD.** The arbitrator said the layoff was proper punishment for Millie's failure to telephone during the second week. Her conduct, he said, reminded him of the story of the bartender who asked the saloon keeper whether Jones could be trusted for a drink. "Has he already had it?" asked the owner. "Yes," answered the bartender. "Then we can trust him for it," was the reply. The arbitrator said Millie apparently operated on that principle when she asked for the third week after she had already taken part of it.

## CASE OF THE BEREAVED STRIKER

One day toward the end of last November, Fred H., a gear cutter in a machine tool plant, called his foreman to report that he would be absent for three days because of a death in his family. In accordance with the union contract and the practice in the plant, three days' leave was immediately granted, for which Fred expected to be paid.

But a few hours later, an unauthorized walk-out took place in the shop, causing a complete shutdown of operations for a week. Under the circumstances, management refused to pay Fred for those three days. "The collective bargaining agreement provides for three days' pay only when absence from work is caused solely by death in the family," the superintendent said. "You didn't lose any money by your absence to attend the funeral because the strike would have prevented you from working anyway. Maybe you're entitled to a few hours' pay to the time the strike began, but that's all."

Eventually, the case went to arbitration under the rules of the American Arbitration Association.

**THE AWARD.** The arbitrator said that if the death had occurred after the strike began, Fred would have been absent because of the strike, not the death, and he would not have been entitled to pay. As it happened, however, he was absent because of the death in his family when the strike started. That determined his status for the next three days. He was consequently awarded three days' pay.

## HEAT TREATING CASE HISTORIES #5

*Concluded from page 26*

For example, the rapid heating of the gears brought them so swiftly to full hardness, that no oil or water quench was used. Only the surface had been heated and the remaining unheated metal caused the parts to chill so rapidly as to become self quenching. This phenomenon should prove extremely useful when hardening certain types of parts that require that their ultra-precise dimensions must be held throughout the heat treatment.

As a precautionary measure, however, the work stations of the machine are equipped for automatic spray or drop quenching of the work by water, oil emulsion or oil. Quenching qualities remain constant because the temperature of the oil emulsion and oil used for quenching is controlled by a combination heating and cooling heat exchanger.

The unique 50KW induction generator and its accessory equipment are said to have many features "designed in" to insure dependable operation and uniform results. Its transformers are controlled automatically to guard against voltage variations and a corresponding change in power output. Components are water cooled, and the cabinet is sealed against changes in or contamination from the shop atmosphere. The unit is air conditioned by means of a water-air heat exchanger so that all parts operate under constant conditions and condensation cannot occur to interfere with operations.

Both temperature controller and power regulator are contained in one compact unit, requiring only the connection of power lines and thermocouple wires. • • •

## NEW FURNACE • • •

*Concluded from page 15*

mentation, and strip chart recorders.

The reinforced concrete pit containing the draw furnace and quench tanks also has a big sub-zero chamber and enough empty space for the future installation of two more furnaces. Purpose of the cold chamber, which was custom built by Commercial Refrigeration Company, Los Angeles, is to permit the transformation of certain exotic alloys —among which H-11, 15-7Mo, and Rene 41 are most prominent in B-70 construction—at temperatures down to -110 F.

Extensive cleaning and inspection facilities have been installed in areas near the heating, quenching, and refrigeration equipment to assure the efficient cycling of all metal treatments. • • •

## CARBON CONTROL • • •

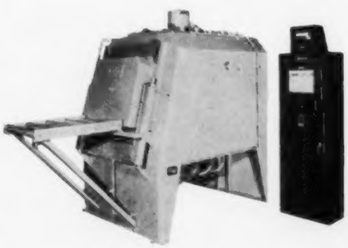
*Concluded from page 23*

Preliminary tests on various grades of steel show that very little grain growth should be expected on certain medium alloy grades such as A-4615 and A-9310 steels at temperatures to 2000 F. Many heats are extremely fine grained at 1700 F. and resist carbon pick up. However, the higher temperatures coarsen the grain enough on these steels to encourage acceptance of carbon, and result in a more uniform case structure. • • •

# NEWS TO HEAT TREATERS...

## Additions to Ipsen Line

The manufacture of a complete line of controlled atmosphere box furnaces has been announced by Ipsen Industries, Inc. Operating temperatures of 2400 F. can be maintained in the smaller units, and larger units will be capable of temperatures to 2250 F.



Ipsen controlled atmosphere box furnaces are available as gas fired, oil fired, or electrically heated units. The units maintain excellent temperature uniformity since the charge is heated by 100% forced convection. The charging door and door plate of the tightly sealed units are of one piece normalized cast meehanite. These castings are rigid and resist warping. Sliding surfaces are machined flat and the door is raised by dual airdraulic cylinders.

Higher temperatures can be obtained because there is no alloy inside the furnace. The protected atmosphere is circulated by a ceramic fan capable of driving the atmosphere at a speed of 2500 feet per minute. Heating is accomplished by means of the Ipsen super alloyed ceramic heating tubes that are impervious to high carbon and high hydrogen atmospheres as well as resistant to the extreme changes of either heating or cooling. An exclusive 100% premix ceramic burner fires upward to assure complete combustion within the heating portion of the tube. The ceramic burner has extremely long life since it is not affected by high temperature operation, or exposure to contaminating type atmospheres. Coupled with the use of Ipsen super alloyed ceramic flame busters, this feature increases heating efficiency resulting in more heat transferred to the work from a given amount of fuel.

Ipsen box furnaces can be manually charged, or they can be used with mechanized loaders and unloaders for production line heat treating operations. Development of box type furnaces is expected to widen the complete line of heat treating equipment offered by Ipsen Industries, Inc. These units are expected to find uses in tool room applications, and for other applications where controlled atmosphere heating is desired, but where it is unnecessary to hold work under controlled atmospheres following the heating operation.

***For further information circle No. 38***

## Beaco Equipment to Represent Sunbeam Line

Sunbeam Equipment Corporation, Meadville, Pennsylvania has appointed Beaco Equipment Company, St. Louis, Missouri, to represent the Sunbeam line of industrial heat treating furnace equipment in Eastern Missouri, Southern Illinois and Western Kentucky.

***For further information circle No. 49***

## 1961 MTI Spring Meeting

The 1961 Annual MTI Spring Meeting was held in Las Vegas, N. M., at the Hotel Riviera April 5 through 7.

The sessions featured both technical and managerial presentations, and were attended by the representatives of the members of the Metal Treating Institute from all parts of the country.

***For further information circle No. 23***

## Lucifer 7000 Series

General purpose bench and floor model furnaces are available in the all new Lucifer Furnaces, Inc. 7000 Series which is manufactured in 22 low cost units. Fourteen of these are floor models while the remainder are bench type. Each will be shipped

as a complete unit, ready to be connected to the power supply.

Hardening, annealing, drawing, preheating and special applications are the uses for this series. Temperatures attainable are 2000 F. and 2300 F. Many Lucifer exclusives are incorporated in this series.

***For further information circle No. 43***

## Branson Thickness Tester

Equipped with a newly developed caliper attachment, a Sonoray ultrasonic flaw detector may now be used to measure thickness of metals and plastics, from one side, to accuracies within ±0.010 in. Both the caliper attachment and the basic instrument itself are marketed by Branson Instruments, Inc., Stamford, Connecticut.

Operation of the caliper is simple. It consists essentially of a fixed, scribed, vertical line, and a second line on a slider, movable across the face of the cathode ray tube. A synchronized dial indicator measures the amount of this motion, permitting the operator to determine thickness directly, without calculations or interpolation. Although pulse-echo equipment, such as the Sonoray, is principally used to ascertain the presence of hidden discontinuities, voids, slag inclusions, and severe porosity, the new accessory permits accurate location of these and similar flaws. Knowing how deeply these imperfections penetrate into sound metal often makes the difference between scrapping the entire component, or salvaging it by machining off the damaged sections.

Shop personnel, familiar with ultrasonic testing, can use the caliper efficiently after a few minutes of training. A reference block of known thickness—and of the same material as the object to be tested—is used to calibrate the instrument.

*For further information circle No. 9*

## ASTM Convention

The 1961 Convention of the American Society of Tool and Manufacturing Engineers will be held in New York City in the Coliseum May 22 through May 26.

At this outstanding conclave more than $12,000,000. in manufacturing equipment will be displayed and some 50 technical papers will be presented at 17 different sessions.

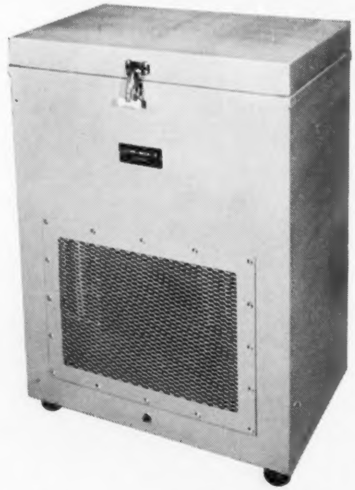
As is customary, outstanding plant tours are scheduled. As a feature of this year's convention, the heat treating plant of Fred Heinzelman & Sons, 790 Washington Ave., Carlstadt, New Jersey, will be included. This plant, one of the newest and most modern in the heat treating field, was completed in 1960 and will have a number of interesting activities to display to metalworking men in all fields.

If you are planning to attend this convention and are interested in latest advances in heat treating, be sure and include the Heinzelman plant on your program.

*For further information circle No. 20*

## Harris Temperature Chamber Marketed

Pictured here is the new Model PR110-B low cost temperature chamber being marketed by A. M. Harris Industries, Inc., Cincinnati.



The unit is ideally suited for stabilization of metals, quick aging of steel, chilling to increase tool life and similar operations designed to extend the length of usability of metals.

Temperature range of the Model PR110-B is from -70 F. to -120 F. The unit is of all steel construction with an air cooled condenser. Outside dimensions are 34 in. by 22 in. by 44 in high. Inside dimensions are 24 in. by 12 in. by 12 in. deep. The unit operates on an electrical circuit of 230 volts, 60 cycle, one phase.

The Harris So-Low cascade refrigeration system allows maximum thermal capacity at all times.

*For further information circle No. 4*

## Metal Improvement Exhibit A Magnet at L. A. Show

One of the outstanding features of the recently concluded Western Metal Exposition held in Los Angeles was the exhibit staged by Metal Improvement Company, of that city.

The Peenamatic Equipment Division displayed new, low cost, convertible, two-way blast machines capable of being operated either as wet or dry blasting units. A tumble action blasting unit for cleaning, peening and deburring of medium sized parts was also on display.

Separately shown were two newly developed blasting nozzles: a lightweight rubber nozzle which is said to improve operator performance while providing outstanding wear characteristics; and a new co-ax nobble which makes it possible to blast and deburr the I.D. of blind holes and bores of large and small diameters.

Also shown were parts whose fatigue life has been greatly improved by scientific, fully controlled, shot-peening.

## Versatile Induction Heater

A Tocco induction heater recently installed at the Convair Division of General Dynamics Corp., San Diego, Calif., is distinguished

*Continued on page 36*

## EFFECT OF HARDENABILITY • • •

*Concluded from page 14*

Apart from well timed tempering, the best method of combating the development of longitudinal cracks, characteristic of fully hardenable tools, is good uniform heating for quenching to a temperature as low as possible.

In specimens which do not harden throughout, the case, when hardened to martensite, has a higher specific volume than the core, which has a troostite structure. The surface zone tends to expand and meets resistance by the core. As a result of the interaction betwen the quenched surface layer and the nonhardened core, compressive stresses develop in the case. Tensile stresses develop in the core. The bow-shaped cracks in not fully hardened specimens are due to the fracture of the core under tensile stress. The proof of this is found in those cases when bow-shaped cracks present in the core do not extend into the hardened zone.

Fracture develops mainly in those sections of the core which are located at the corners of the specimen or tool. This happens because such zones are under triaxial tension, which reduces the ductility or plasticity of the steel so that failure occurs at lower stresses.

• • •

## NEWS TO HEAT TREATERS

### New "Kleenmetal" Furnaces by Rockwell

A new line of controlled atmosphere furnaces has been announced by W. S. Rockwell Company, Fairfield, Connecticut. They are known as Rockwell-Mern "Kleenmetal" Furnaces, designed by Norman Acker, who is widely known for his development of many successful atmosphere type heat treating furnaces and gas generators.

Most important in the line is the batch type furnace. It is furnished with automatic transfer and loading and unloading platforms, cooling chamber and sealed quench. Thus, this completely integrated, "packaged" unit available in three standard hearth sizes and in special sizes, is capable of meeting the highest metallurgical quality standards in carburizing, carbonitriding, carbon restoration, hardening, annealing, normalizing, drawing, brazing and sintering.

The complete operating cycle is automatically controlled. The work container on the loading table advances into the heating chamber and the front door closes automatically. The work container rests on a silicon carbide hearth, perforated to permit circulation of heat through the load. Heating is provided by gas-fired, alloy radiant tubes with internal helical baffles. The heat so generated is circulated by an alloy fan around the work. Protective atmosphere is supplied by a separate gas generator.

***For further information circle No. 61***

## NEWS TO HEAT TREATERS

*Continued from page 34*

for its ability to perform a variety of brazing, heat treating, annealing, and testing operations.

The unit is presently used in the ceramics section of Convair's materials and processes laboratory to accelerate the melting of refractory compounds. Since it is mounted on

a dolly, it can be moved to any plant area where it may be needed in a matter of minutes.

The 68 amp., 15 kw., 220 v. device has a motor generator and was designed to operate at the relatively low frequency of 10,000 cycles to assure good heat penetration.

It uses copper coils in a more or less conventional manner. However, an operator will not suffer burned fingers if he happens to touch a working coil because the latter will never have a charge of more than 10 or 15 volts.

Where there is an accessibility problem, the heater's conversion compartment can be separated from the remainder of the equipment and utilized some distance away.

Percentage-rated meters make it fairly simple for an operator to vary the heater's output in accordance with the thermal characteristics of different materials.

Convair researchers have devised a special compartment which will permit use of the heater's coil in various inert atmospheres to heat treat and test such things as ceramic and refractory coatings at temperatures up to 4000 F.

*For further information circle No. 6*

## Armour Distributors

Four new anhydrous ammonia distributorships covering six locations have been announced by Armour Industrial Chemical Company.

Merchants Company, Inc., Hattiesburg, Mississippi, will warehouse, sell and deliver ammonia in cylinders in that city. The same company will be responsible for sales in Gulfport and Vicksburg, Mississippi.

Other new distributors are Sierra Chemical Company, Reno, Nevada; Thompson-Hayward Chemical Company, San Antonio, Texas; and Midwest Carbonic Company, Inc., Madison, Wisconsin.

*For further information circle No. 50*

## Spray De-Greases Electric Motors

Quick thorough action and complete safety is claimed for Sprayon No. 701 Electric Motor De-Greaser

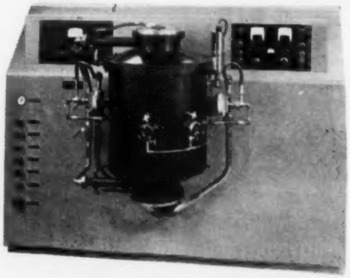
by the maker, Industrial Supply Division, Sprayon Products, Inc., Cleveland, Ohio. Packed in a 16 oz. aerosol can, the de-greaser is part of Sprayon's line of 47 maintenance and production aids in self-spraying containers.

Specially made for electrical equipment, Sprayon No. 701 Spray is reported to be easy to use. No washing or flushing is needed. It is simply sprayed on and wiped off. The liquid penetrates quick and deep, loosens dirt, liquefies heavy greases and tars. It is non-corrosive, non-staining, non-toxic and it will not damage insulation.

*For further information circle No. 10*

## Pyrolytic Development Unit

The newest addition to the growing line at Vacuum Specialties Company, Somerville, Massachusetts, is a furnace designed for ultra-high



temperature. The unit's general application is for high temperature work under vacuum, controlled reducing or inert atmospheres. Specifically, it is designed for work with pyrographite or other new pyrolytic materials.

The water cooled stainless steel furnace chamber contains only various forms of carbon for insulation and Vacuum Specialties' unique split graphite element with a hot zone of 4 in. ID by 8 in. high. Provision is made for introducing water cooled gas injectiors at top and bottom, with ample reserve in the power supply to reach full temperature with the additional heat drain of injector arrays. Pyrometric measurement and observations of internal reactions are made through several shielded and cooled sight ports.

A common problem in pyrolytic work is short element life due to deposits on the element or to element reactions, at very high temperatures, with decomposition products of the feed gas. The element in this furnace is specifically designed for easy replacement. Spare elements are economically fabricated by the customer from standard graphite pipe.

The main cabinet supports the furnace chamber and contains the saturable reactor type power supply, vacuum pump, feed gas piping, water manifolding, controls and vacuum gauges. It is designed for

single point connection of all services.

A variety of sizes are available from the 4 in. furnace described above to the 30 in. diameter furnace. The larger furnaces are custom built to meet customer's requirements.

*For further information circle No. 42*

## Long Wearing Nozzle

A new, lightweight and long wearing rubber nozzle for wet or vapor blasting machines has been developed and marketed by Metal Improvement Company, Los Angeles.

The nozzle is outstanding in ease of handling, requiring no counterbalancing. According to company engineers, the gun will outlast much heavier nozzles and will, by its easy manipulation, improve operator performance and production. Parts cannot be damaged if touched by the gun. Metal parts are non-ferrous and clamps on the lengths of hoses supplied with the gun are stainless steel.

This gun fits wet blast machines of most makes and models.

*For further information circle No. 8*

## B & L Unveils DynaZoom

Bausch & Lomb has announced a major change in instrument design with the introduction of the new DynaZoom microscopes. The line has been especially created for laboratory use in educational institutions, public health and hospital laboratories, industry and many types of quality control work. It is reported to be the first laboratory microscope to feature a completely integrated zoom optical system.

The new MicroZoom optical system eliminates image blackout and focus shift, while permitting continuous, crystal clear magnification within the entire range of the instrument. The magnification range of the series extends from 17.5x to 1940x, and a specimen can be fully examined in infinite detail without mechanical or optical limitations.

A single, 10x eyepiece now performs the job of several in the conventional system, since the new MicroZoom optics provide 1x to 2x magnification, or any fractional point in between. Specially designed objectives produce greater detail without altering working distance, focus or usable field. In the area of measurement, MicroZoom simplifies calibration of the eyepiece micrometer disc.

Six interchangeable bodies are

*Continued on page 40*

# ***MANUFACTURERS'*** LITERATURE

**For your copy circle the number on the Readers' Service Card**

**Catalog supplement CS-600** has been announced as an appendix to its current Chromalox industrial electric heating catalog, No. 60, by Edwin L. Wiegand Company, Pittsburgh. The new supplement contains specifications and product illustrations of Chromalox electric heater bands, air heating elements, blower-type heaters, immersion units, engine heaters, mineral insulated heating cable, special radiant heaters for process and comfort heating, controls and various other elements and equipment.

***For further information circle No. 16***

**Catalog G-25** shows complete line of differential expansion type temperature controls available from Burling Instrument Company. Included is a general description of their operation together with a picture and brief specifications of each model. Both electric and pneumatic instruments are covered. Instruments are available for temperatures up to 2000 F. and in choice of standard, water tight, or explosion proof enclosures.

***For further information circle No. 14***

The American Welding Society has announced the availability of a new revision of **AWS Standard Welding Terms and Their Definitions.** It is the first revision in 12 years and many changes have been incorporated and much new material added. This is considered to be the most important Standard published by the Society. It is the dictionary of welding and does for welding what Webster does for the English language. A new Master Chart of Welding Processes has been prepared in conjunction with the AWS Definitions. The 39 recognized welding processes are presented in a new layout designed for ready reference. Colors are used for the first time to separate the various welding processes and this provides instant identifiable in 2 sizes: an 8½ in. by 11 in. size for desk use and a 22 in by 28 in. size for wall use. Copies of the AWS Definitions, including desk Chart, may be obtained for $2.00 per booklet. Copies of the wall or desk Chart may be obtained separately at a list price of $1.50 and $ .50 respectively.

***For further information circle No. 15***

**Bulletin No. 999-60** describes the improved Michigan Tool Company Model 999 abrasive hard gear finishers and illustrates how they are used for final surface conditioning of gear teeth after hardening. In addition to giving complete physical specifications on the machines, the bulletin discusses various uses, how to produce crowns and tapers, cutting fluids, new resins for hones, automatic and manual hone dressing, and automatic loading and unloading.

***For further information circle No. 74***

In an attractive, **comprehensive catalog,** the Diamond Tool Research Company of New York City has made available photographs, diagrams, specifications and pricing information for its complete line of diamond dressing tools, as well as catalog inserts covering loose industrial diamonds, diamond compounds and pressure tested powders, saw blades for masonry and concrete, masonry drilling bits, mining bits and diamond grinding wheels. One section of the new catalog discusses "selecting the right type of diamond tools for specific jobs." A careful review of the various grades of diamonds necessary for different grinding wheel dressing applications is given. Various specialty tools are illustrated and discussed as having solved specific problems for industry. Useful information is to be gained in all phases of industrial diamond product application by all those who read this entire catalog #A-60.

***For further information circle No. 72***

Bulletin **No. 800,** a new eight page booklet, describing and illustrating vacuum type furnaces, has been published by Lindberg Engineering Company, Chicago. Pictures and drawings in this bulletin show hot wall vertical retort vacuum furnaces, horizontal retort vacuum furnaces, vacuum bell type furnaces, cold wall vacuum furnaces and a vacuum atmosphere retort tube for research and pilot plant use.

***For further information circle No. 59***

**Bulletin No. 227A** tells how Pangborn Corporation's patented Rotoblast impeller uses controlled centrifugal force for its blast cleaning power. The revised eight page booklet contains diagrams and cut away drawings showing how the latest de-

sign refinements enable Rotoblast to produce a quality of cleaned surface previously impossible to achieve by any other method. Manufactured in four sizes, Rotoblast units are designed to meet specific blast cleaning requirements, yet are suitable for almost any application. The booklet describes many new modifications developed to increase production speed yet reduce cost of operation.

*For further information circle No. 73*

A four page **Catalog Section 24A** issued by Rolock Incorporated of Fairfield, Connecticut, details this company's new Reversible Endothermic Gas Generators which are available in rated capacities of 500, 750, 1000, and 1500 C.F.H. with listed maximum capacities of 650, 875, 1250, and 1750 C.F.H. respectively. Unusual features claimed for this equipment include complete reversibility, with resultant self cleaning of catalyst beds, precise gas-air metering and mixing, complete cracking of gas, and triple cooling of prepared atmosphere to prevent reverse reaction. The catalog section describes the equipment in detail, includes flow diagram, equipment list, and specifications.

*For further information circle No. 58*

A new catalog, **RT-60,** recently issued by Wilson Mechanical Instrument Division, American Chain & Cable Company, Inc., is guaranteed to make selection of hardness testing equipment a much easier task. In addition to containing information on the principle of the Rockwell hardness test and of microhardness testing, this catalog illustrates and describes Rockwell and Superficial hardness testers, and Tukon microhardness testers in a manner that makes it easy to select the proper model for specific requirements. The catalog also illustrates and describes several models designed for specific uses: fully automatic models, motorized models, those for testing at elevated temperatures, internal hardness testing, the new Wilson mobile tester, diamond "Brale" penerators and the various Rockwell accessories, with information on how to order.

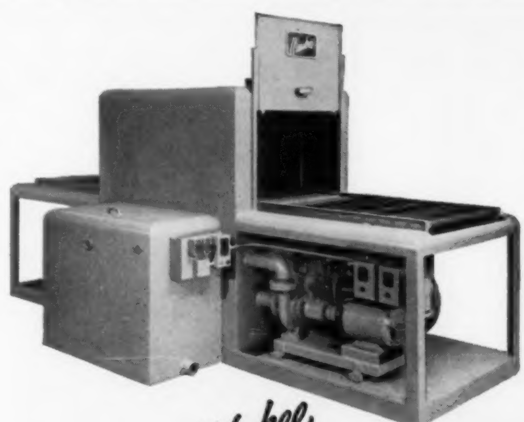
*For further information circle No. 54*

**Box Furnaces,** Bulletin GED-4179, describes General Electric's new box furnaces without cooling chamber for operation in heat treating, tool rooms, heat treat department, laboratories, or pilot operations. Text explains when to use ribbon or silicon carbide resistors.

*For further information circle No. 19*



*For further information circle No. 52*



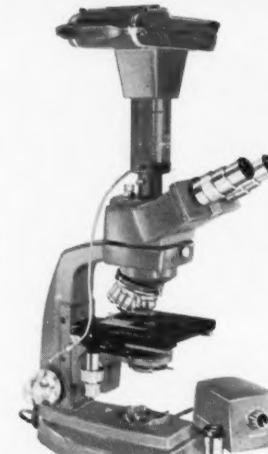


*For further information circle No. 55*

## NEWS TO HEAT TREATERS

*Continued from page 37*

available in the new series, including three monoculars, a binocular, a photo-binocular, and a photo-monocular. For greater versatility of use and interchange of accessories, one stand is common to all models. The



eye level always remains constant, due to focusing the stage instead of the body. The substage, either plain or rack and pinion, accommodates a selection of condensers and an iris.

The new 10x, 43x, and 97x objectives are color-coded for quick identification; the 97x (oil) objective, and all condensers have been increased to 1.30N.A. Smooth, ball bearing movements control nosepiece and stages, eliminating the need for lubrication. A circular 148mm diameter glide stage is particularly well adapted to scanning.

New 35mm. and Polaroid Land Camera attachments are available for models adapted for photomicrography. These cameras are focused through the visual eyepiece tubes so that it is no longer necessary for separate refocusing of the specimen in the film plane.

The closed type base provides a firm support for illuminator accessories. It will accommodate, interchangeably, a mirror for use with separate light sources, Opti-Lume for routine visual examination, or

the "HI-Intensity" variable power built-in base illuminator for bright field, dark field, phase contrast, and photomicrography.

Pictured here is a photo-binocular microscope with specially designed Polaroid Land Camera attachment.

*For further information circle No. 2*

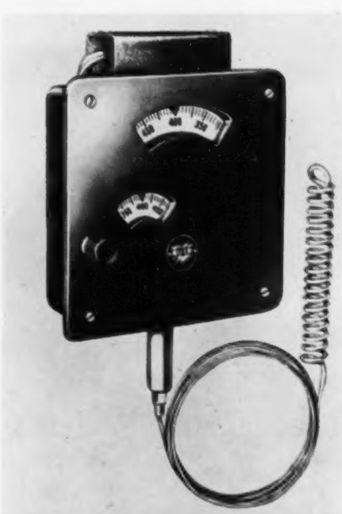
### Russian Heat Treating Magazine Presented

A publication entitled *Heat Treatment of Metals,* published in Russia, the only journal on the subject in that country, is now being regularly translated into English by Henry Brutcher — Technical Translations. An index of available material on this subject as published in the Russian journal is available on request.

*For further information circle No. 30*

### Temperature Control

The E32NA Dual Switch Indicating Temperature Control is one of the latest units to be added to the United Electric Company's line of industrial temperature and pressure controls.



The E32NA is a versatile wide range temperature control from -150 to 650 F., ideally suited for such applications as ovens, baths, environmental test chambers, molding machines, plant processes, etc. It

*Continued on next page*

## NEWS TO HEAT TREATERS

*Continued from preceding page*

features a calibrating mechanism which makes possible easy replacement of the thermal assembly in the field with no loss of calibration accuracy.

The control contains two separate switches permitting switch action above or below the index set point and control of up to four independent circuits. The index scale is calibrated in the same easily read values as the indicating scale to eliminate visual errors.

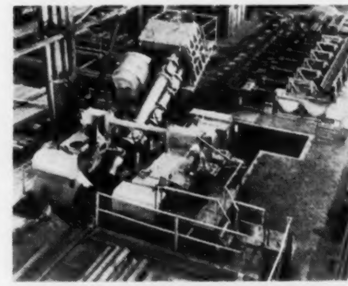
The thermal system consists of a bulb, capillary and bellows filled with temperature sensitive liquid. The bellows expand or contract with heating or cooling, thus actuating the snap-action switches at the preset temperature points.

Electrical rating is standard 15 amps 115/230 Volts AC with many types of switches and other ratings available.

***For further information circle No. 41***

### Heavy Duty Straightener

The largest straightening machine of its kind ever to be built, a heavy duty Sutton 5BC Straightener has been installed at the Sheffield Steel Division of Armco Steel Corporation, Houston, Texas.



Used for precision straightening of alloy, heat treated hot rolled bars from 3 in. to 9 in. diameter for oil country drill collar stock, it is part of a complete line of rotary straightening machines manufactured by Sutton Engineering Company, Pittsburgh, Pennsylvania for tubes and bars of all modern metals.

***For further information circle No. 7***



### Tool Steel With A Musical Note

The following appeared in Bethlehem Steel Company's *Tool Steel Topics* and METAL TREATING thought it worth passing on to our readers:

Believe it or not, this is a true story. A man called at the warehouse of one of our tool steel distributors, carrying in his hand a bar of tool steel about 3/4 in. diameter by 18 in. long. When asked what he wanted, he flung the bar onto the floor, where it rang out with a loud "cling-g-g."

"Do you have any tool steel which sounds like this?" he asked, dropping the piece once again. "I'm in a hurry. I don't have time for a detailed analysis of this grade, nor any fancy metallurgical studies. I need a four ft. piece, and I need it now, but it's got to have the same ring as this piece."

Undaunted, the distributor had several of his men take relatively short lengths from the storage racks, and drop them to the floor. Soon the warehouse sounded like a band

*Continued on page 44*

 *For further information circle No. 34* 

## NEWS TO HEAT TREATERS
*Continued from page 42*

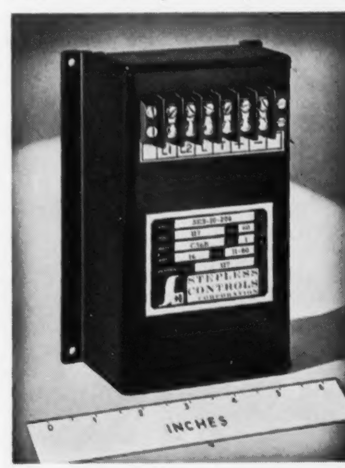
of amateur musicians running through the "Anvil Chorus." Suddenly the customer yelled, "That's it. The one you just dropped sounded real good." And he walked out with the piece under his arm.

The distributor shook his head. "I never thought music could creep into this business," he said. "We've sold tool steel in flats for years. Now it looks as though we'll have to carry sharps as well."

### Solid State Stepless Control For Furnaces

A new device claimed to be the first application of solid state switching to produce full range proportional control by use of silicon controlled rectifiers has been announced by Stepless Controls Corp., Waltham, Massachusetts.

Designated the Power-Prop, the unit is basically an input control




that will operate from any pyrometer with a proportional DC voltage output signal. It has all the advantages of the saturable core reactor system with such additional improvements as the elimination of the need for matching loads, the capability to shut the power fully off, and small size and weight. The new control also makes obsolete the magnetic contactor system which produces a seesaw effect and is susceptible to the costly problem of contactor failures.

*For further information circle No. 3*

These cast HT alloy work trays carry farm tractor parts through endothermic, ammonia and carburizing atmospheres. Conveyor mechanism has a loading section that can be raised or lowered pneumatically, simplifying handling problem.

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